

## DEEP-SEA FISHES OF THE BERMUDA OCEANOGRAPHIC EXPEDITIONS

Family ARGENTINIDAE

BY WILLIAM BEEBE

ARGENTINIDAE

Salmonoid Isospondylous fishes having an orbitosphenoid, no opisthotic, no upturned vertebrae at base of caudal fin, no teeth on the meso-pterygoids, a mesocoracoid and inferior parapophyses.

Genus **Bathylagus** Günther 1878

GENERIC CHARACTERS: Body compressed and elongate, covered with thin, deciduous scales of medium size; no regular photophores; head short and compressed, with thin, membranous bones; mouth very small, transverse, anterior; maxillary very short, dilated; the teeth of both premaxillary and maxillary rudimentary or absent; minute teeth present on mandible, vomer and palatine; eye very large; pectoral and pelvic fins inserted close to ventral profile, the pelvics under the dorsal which is close to the middle of the body; anal fin moderate, with up to about 25 rays; adipose fin present; gill opening narrow; gill membranes united and not attached to isthmus; gill-rakers rather long; pseudobranchiae well developed; 3 or 4 branchiostegals.

NUMBER OF SPECIES: Twelve species have been recorded, of which two have been taken by the Bermuda Oceanographic Expeditions.

GEOGRAPHICAL DISTRIBUTION: Members of the genus are known from the Atlantic and Antarctic Oceans and from the Pacific coast of North and Central America.

VERTICAL DISTRIBUTION: The species of *Bathylagus* are all bathypelagic. Most of the Bermuda examples came from between 600 and 800 fathoms, with an extreme range of 400 to 1000 fathoms. The temperatures in the trawling area at the latter depths were found to be about 52.8° Fah. (11.5° C.) and 38.7° Fah. (3.7° C.)

respectively. The pressures at the same depths are 1176 and 2940 pounds per square inch.

ABUNDANCE:

*World*: All of the species of *Bathylagus* have been known previously from less than a score of specimens each.

*Bermuda*: A total of 119 specimens have been taken by the Bermuda Oceanographic Expeditions. In the order of abundance of individuals in the nets, *Bathylagus*, the only deep-sea representative of its family, ranks seventh among the deep-sea *Isospondyls* (in a total of 42 genera) and about fifteenth among all of the deep-sea fishes (including at least 120 genera).

*SOCIABILITY*: The two Bermuda species of the Bermuda collection show some evidence of sociability, two or three specimens, not always of approximately the same size, having been found in a single net upon thirteen occasions. Only once, however, were specimens of both *B. benedicti* and *B. glacialis* brought up in the same net.

*FOOD*: Of the seventeen stomachs examined only four contained any food at all; this consisted entirely of small crustaceans. Unrecognizable matter was, however, present in most of the intestines.

*ENEMIES*: *Bathylagus* has not yet been found in the stomach of any animal, nor have parasites been observed.

*VIABILITY*: None of the Bermuda specimens has been brought alive to the surface.

*SIZE*: The longest known specimens measure about 200 mm. The largest Bermuda female, of 94 mm, seemed near breeding condition.

*DEVELOPMENT*: Adolescents far outnumber the uncommon post-larvae and rare adults in the Bermuda collection. All occurred throughout the Bermuda trawling seasons from April to September. No larvae were taken.

In comparison with the adults, the young of both species have in common the following traits: A slight to moderate amount of pigment; slender bodies; small eyes; mandibular teeth developing more rapidly than those of the vomer and palatine with which they articulate; scales appearing in early adolescence, at 25 or 30 mm; unpaired fins almost fully developed in post-larval stage, ahead of the paired fins; traces of finfolds persisting into late adolescence as elongate adipose fins; jaws, parasphenoid, proximal parts of

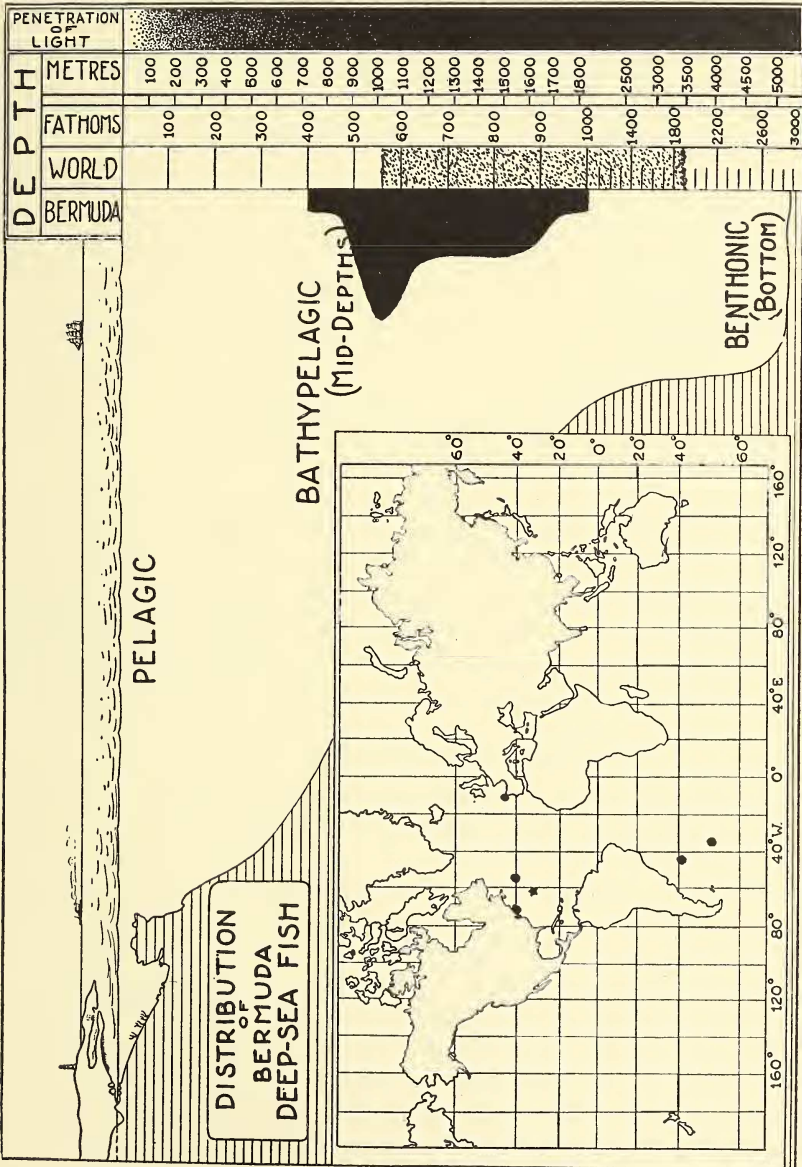


Fig. 26. *Bathylagus benedicti* Goode and Bean. The approximate geographical and vertical distribution of all recorded specimens. The relative number of specimens taken at different depths by the Bermuda Oceanographic Expeditions is shown diagrammatically at the right, for comparison with the previously known vertical range of the species.

finrays, caudal base and anterior vertebrae in the order named are the first bones to ossify.

The general characteristics of the post-larvae, adolescents, and adults of *Bathylagus* agree with the definitions of those stages given in the Introduction (p. ); their specific characteristics will be found in succeeding pages in the discussions of the development of each species.

#### KEY TO THE IMMATURE SPECIMENS OF BERMUDA BATHYLAGUS

- A. General body color pale brownish with two conspicuous, lateral bands of pigment spots, one above and one below lateral line, from shoulder to caudal base; eyes, viewed from above, not converging anteriorly. . . . . *B. glacialis*  
 AA. General body color blackish; no lateral rows of pigment spots; eyes, viewed from above, definitely converging. . . . . *B. benedicti*

#### *Bathylagus benedicti* Goode and Bean 1895

#### SPECIMENS TAKEN BY THE BERMUDA OCEANOGRAPHIC EXPEDITIONS

20 specimens; April to September, 1929 to 1931; 400 to 1000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12' N. Lat., 64° 36' W. Long.; Standard lengths from 18 to 91 mm.

#### PREVIOUSLY RECORDED SPECIMENS

9 specimens; 550 to 1925 fathoms; North and South Atlantic; Standard lengths from 108 to 158 mm. (Fig. 26).

#### ADULT SPECIFIC CHARACTERS

(Fig. 27B)

*Bathylagus benedicti* is deeper (depth 5 to 5.6 in length) than any of the other members of the genus having the dorsal origin nearer snout than caudal base and the anal with at least 16 rays, except *B. antarcticus*, *B. pacificus* and *B. euryops*. From the first it is distinguished by the fewer anal rays (19, not 22 to 25), from the second by the smaller head (4.2 to 4.3, in length, not 4 to 4.1) and larger eye (about 2 in head, not 2.25 to 2.5), and from the third by the longer base of the anal fin (about 5.6 in length, not 6.2 to 6.7). *Color*: Skin of whole body as well as deeper layers of dermis dark



brownish or blackish; scale pouches rimmed with black; the darkest regions are the interorbital, lower part of head, opercles and abdomen. *Proportions*: Depth in length 5 to 5.7; head in length 3.9 to 4.3; eye in head 2 to 2.2, greater than post-orbital region; interocular width in head 2.7 to 3.2, interorbital width in head 5.7 to 6.4; snout in head 6; origin of dorsal nearer snout than base of caudal; pelvic origin under last half of dorsal; origin of anal 2.9 to 3.2 times as distant from end of snout as from base of caudal; length of anal base in that of fish 5.6 to 5.7. *Finray Counts*: Pectoral 10; pelvic 9; dorsal 9 to 10; anal 18 to 19. *Teeth*: Rudimentary or absent in premaxillary and maxillary; minute and fairly numerous on mandible, vomer and palatine. *Scales*: About 40 in a longitudinal series. *Gill-rakers*: About 13 in lower part of first branchial arch.

#### DEVELOPMENT

The Bermuda collection contains nineteen young fish and one which is probably completely mature. The young specimens fall into two groups, the first consisting of specimens with characters about intermediate between a post-larval and adolescent stage, and a second group of older fish which are obviously typically adolescent. The relation of these growth stages to standard length and numerical abundance is shown in the following table.

**TRANSITION STAGE BETWEEN POST-LARVA AND ADOLESCENT:** (Fig. 27A). Eight specimens of the post-larval transition stage were taken, measuring between 18 and 22 mm. They differ from adolescents and adults in their proportions, the presence of finfold traces, and the lack of ossification. They are referred to a transition stage rather than to the true post-larval due to the following points: All of the finrays are distinct; there is no characteristic contour unlike adolescent and adult, as is so frequently found in post-larvae; and the scales are well developed.

*Trawling Data*: For the description of all of the characters except those of the skeletal system the following specimen was selected: Department of Tropical Research No. 9,653; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 41; April 25, 1929; 12 miles south-east of Nonsuch Island, Bermuda; Standard length 18 mm.

No. 15,416 (Cleared and Stained Collection No. 1064), 18 mm, was examined for skeletal characteristics.

THE RELATION OF GROWTH STAGE TO LENGTH AND NUMERICAL ABUNDANCE IN  
*Bathylagus benedicti*

Length in mm	Larvae	Transitional Larvae	Post-larvae	Transitional Post-larvae	Adolescents	Transitional Adolescents	Adults	Total
18-20				7				7
21-23				1				1
24-26					2			2
27-29					1			1
30-32					1			1
33-35					2			2
36-38					3			3
39-41					1			1
42-44								
45-47								
48-50								
51-53					1			1
91							1	1
	—	—	—	—	—	—	—	—
				8	11		1	20

*Measurements and Counts:* Total length 21.7 mm; standard length 18 mm; depth 2.7 (in length 6.7); head 5.4 (in length 3.3); eye 1.9 (in head 2.8); snout .75 (in head 7.2); maxillary 1.3 (in head 4.6); interocular 1.9 (in head 2.8); snout to anal origin 14, the first finray 3 times nearer caudal base than tip of snout; anal base 3 (in length 6); pectoral rays 10; pectoral length 2.7; pelvic rays 9, origin under 7th dorsal ray; pelvic length 1.8; dorsal rays 10; anal rays 18; caudal rays XI + 11 + 10 + X; adipose length 3 (in anal base 1); gill-rakers well developed.

*External Characters:* The entire fish is brownish, with the body almost uniformly speckled with small black chromatophores. The upper postorbital region is pale and translucent; the interorbital, jaws, opercles and abdomen very dark, brownish-black. Iris black.

The moderately compressed and elongate body tapers symmetrically from the nape to the caudal base, where the depth is over half that of the shoulder. The bases of all of the fins are noticeably elevated.

The top of the head, scarcely raised above the level of the nape, is broad and flattened, the snout convex, and the lips full. The gradual curve of the opercular membranes mark the ventral cephalic profile below the mouth and on backward to the gill opening. The diameter of the eyes is less than the length of the postorbital region

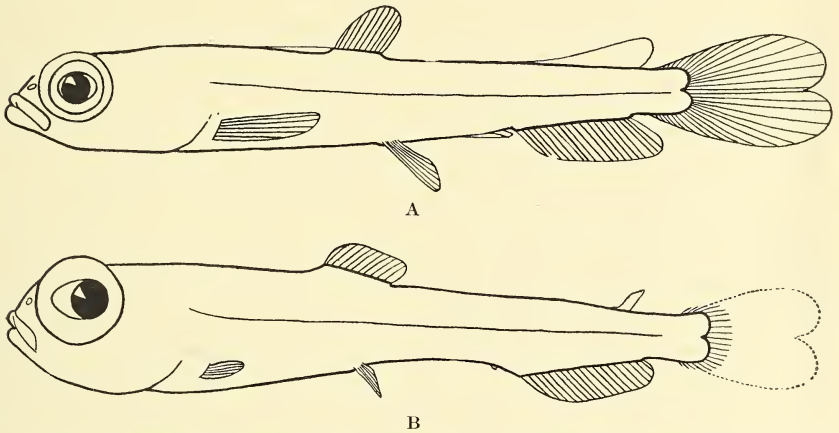


Fig. 27. *Bathylagus benedicti* Goode and Bean. A, transitional post-larva, 18 mm.; B, young adult, 91 mm.

and less than twice that of the snout. They converge anteriorly, their dorsal portion being slightly elevated above the interorbital profile. Although the socket holding the lens has an anterior scallop, which possibly permits a forward movement or rotation of the lens, the iris and eyeball are both perfectly round. The nostrils are widely separated, placed slightly nearer the anterior margin of the eye than the tip of the snout, and are of moderate size. The broad and exceedingly delicate maxillary reaches the anterior edge of the iris.

There are single, close-set series of exceedingly minute teeth on the premaxillary and mandible; maxillary toothless; vomer with one pair of comparatively large fangs; palatine toothless.

Around the eye and along the mandible minute pores are arranged as in the adult. The lateral line follows the midline of the side, and is conspicuous. The operculum extends upwards to the horizontal through the middle of the eye.

The scales are well developed, and, as far as can be determined

from the scale pouches, are arranged as in the adult. Individually, they differ in having only about one-fourth as many circuli as in the adult fish.

The rays of all of the fins are distinct, though very soft. The paired fins are placed close to the ventral profile. The caudal is deeply forked. Between the last of its dorsal profile spines and the first of its long, terminal rays the tip of the urostyle projects obliquely upwards and back. The adipose fin originates in front of the vertical from the anal origin and equals in length the anal base. In front of the dorsal are traces of a finfold, and, ventrally, the extreme tip of the gut protrudes from the remains of a pre-anal finfold.

*Skeletal System:* There is no trace whatever of ossification.

**ADOLESCENT:** The adolescents of the collection are eleven in number and measure from 24 to 51 mm. They are typical of that growth stage in closely resembling the adult, but in having minor external differences, a partially ossified skeleton and immature gonads. Descriptions of characteristic examples follow.

*Trawling Data:* All of the characters except those of the skeletal system are taken from Department of Tropical Research No. 12,418; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 380; Aug. 16, 1929; 8 miles south of Nonsuch Island, Bermuda; 700 fathoms; Standard length 37 mm.

No. 11,414 (Cleared and Stained Collection No. 860), length 40 mm, furnishes the data for the remarks on the skeletal system.

*Measurements and Counts:* Total length 42.2 mm; standard length 37 mm; depth 6.6 (in length 5.6); head 9.3 (in length 4); eye 3.8 (in head 2.4); snout 1.6 (in head 5.8); interocular 4 (in head 2.3); interorbital 2.4 (in head 3.9); distance from snout to anal origin 29, the first finray 3.1 times nearer caudal base than tip of snout; anal base 6.3 (in length 5.9); pectoral rays 10; pectoral length 2; pelvic rays 9, origin under 8th dorsal ray; length longest pelvic ray 2.3; dorsal rays 10; anal rays 19; adipose length 1.7 (in anal base 3.7); scales in a longitudinal series, about 39; gill-rakers in lower half of 1st branchial arch.

*External Characters:* The general color, contour and proportions closely resemble those of the adult except that the body is slightly slimmer and the head longer. There are altogether 6 pairs of vomerine and palatine teeth.

The general arrangement of the scales also follows closely that



of the adult in so far as it can be determined from the scale pouches. Two or three lateral line scales remain on each side. Fig. 28B represents one taken from the left side at the vertical from the first anal rays, the 23rd from the opercle. It is an almost circular oval, longer than deep, with the anterior border interrupted by two deep scallops, and the posterior by a key-hole-shaped indentation. Over half of the scale is exposed, and the apical region is decidedly convex, not noticeably thinner or more delicate than the rest of the scale. In general character it is cycloid and marked only by circuli, there being no trace either of annuli, radii or a definite center. There are about 25 circuli between the central canal and the dorsal border, running from the basal portion of the scale straight to the apical margin where they terminate abruptly. An equal number is found ventrally, but from the entrance to the pore duct in the basal portion to the middle of the anterior border there are but eight, spaced over twice as broadly as the more posterior ones just mentioned. The course of the lateral line through the scale is simple and unbranched: One basal pore opens on the outer face of the scale, forming the entrance to a raised duct; this terminates in a central pore opening on the inner face of the scale and in contact with that portion of the succeeding scale which is immediately in advance of its outer, basal pore; finally, there is an apical pore, opening on both outer and inner faces of the scale, its posterior margin confluent through a narrow canal with a central indentation in the posterior margin of the scale; this forms the key-hole-shaped interruption of the border mentioned above; the duct is lined with skin. Length of scale 1.4 mm; breadth 1.3 mm.

*Osteology:* The jaws and margins of the quadrate are strongly ossified, the parasphenoid and edges of the opercular bones to a lesser degree. The remaining bones of the head show no trace of it. The extreme anterior end of the vertebral column is slightly ossified, while the proximal portions of the pectoral rays, the proximal part of the lower terminal caudal rays, and the end of the interior portion of the urostyle are very feebly ossified. Exteriorly, the unossified tip of the urostyle still projects slightly.

ADULT: (Fig. 27B). But one mature specimen was taken, and it (a male) is not in breeding condition. Its description follows.

*Trawling Data:* Department of Tropical Research No. 19,529; Bermuda Oceanographic Expeditions of the New York Zoological

Society; Net 962; September 29, 1930; 8 miles south of Nonsuch Island, Bermuda; 800 fathoms; Standard length 91 mm.

*Measurements and Counts:* Standard length 91 mm; depth 16 (in length 5.7); head 23 (in length 3.9); eye 11.8 (in head 2); snout 3.8 (in head 6); maxillary 4.8 (in head 4.8); interorbital width 3.6 (in head 6.4); interocular width 7.2 (in head 3.2); snout to anal origin 67, the insertion of the first finray 2.9 times nearer the caudal base than the tip of the snout; anal base 16 (in length 5.7); pectoral rays 19; pectoral length (broken) 4.5; pelvic rays 9, originating under 7th dorsal ray; length of longest pelvic ray (broken) 5.2; dorsal rays 10; anal rays 18; adipose length 1.6 (in anal base 10); scales in longitudinal series about 40; gill-rakers in lower half of 1st branchial arch 13.

*External Characters:* The skin of the whole body is deeply pigmented with brownish black, darkest on the margins of the scale pouches, in the interorbital region, lower part of the head, the opercles and the abdomen, in the order named.

The body is compressed, elongate and deepest in front of the dorsal fin. From here it tapers to the caudal base, which is less than one-third the maximum depth. All of the fin bases are somewhat elevated. The head is rounded in general contour, the crown slightly elevated above the level of the nape, the snout very short and blunt, the full upper lips overhanging the lower, and the united gill membranes, visible ventrally below the tiny mouth, curving backward to the small gill opening. The enormous, round eyes are elevated nearly a fifth of their diameter above the dorsal profile of the interorbital region. They are larger than the postorbital portion of the head and, when viewed from above, converge anteriorly. The socket in which the lens is set is slightly elliptical, with a shallow, anterior scallop, less marked than in the adolescent. The nostrils are widely separated by the broad, flattened, upper surface of the snout, and are placed nearer the anterior margin of the eye than the snout's tip. The delicate, paper thin maxillary extends a little beyond the vertical from the anterior margin of the eye.

The premaxillary and maxillary are entirely toothless. In each half of the mandible 37 very small teeth are found, all equal in size and slanting obliquely backwards, closely resembling the teeth of a saw. These articulate with 9 pairs of slightly larger teeth divided between the vomer and palatine, all triangular and erect, and largest near the premaxillary symphysis.

The gill openings are very small, the dorsal border not reaching the horizontal from the ventral border of the eye.

A number of pores are found around the eye and along the mandible.

All of the scales except one (Fig. 28A) are missing, but judging from the scars, those in the anterior part of the body and on the opercula were fully three times the size of those at the caudal base.

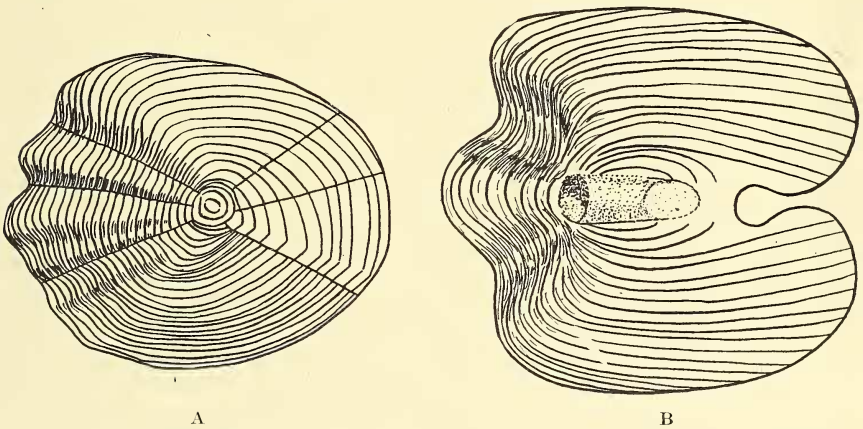


Fig. 28. *Bathylagus benedicti* Goode and Bean. Scales. A, from 91 mm. specimen, 21st scale in 2nd row below lateral line, above anal origin ( $\times 12.5$ ); B, from 37 mm. specimen, 23rd scale in lateral line, above anal origin ( $\times 39$ ).

There were about 40 in a longitudinal series and five rows, exclusive of profile and fin-base rows.

**Scaled Areas:** The fish is entirely scaled posterior to the vertical from the posterior border of the lens of the eye.

**Attachments:** The scales are imbricated; each one is very loosely attached within a comparatively shallow, black-lipped pouch, leaving about one-half of the scale exposed. Only one scale was left on this specimen.

**Number:** The number of scales on the head is indeterminate. On the left side there are about 212. Taking into account the 47 scales of the dorsal and ventral profiles, a total of 518 on the entire body may be regarded as a close approximation of the true number. As the scales themselves are missing, the count has to be made from the scale pouches.

**Arrangement:** Excluding the scale rows of the dorsal and ventral

profiles, and those of the dorsal and anal fin bases, there are five longitudinal rows of scales, continuous from nape to caudal base. The numbers of scales in these rows, as seen from the left side is as follows:

Dorsal profile—Nape to dorsal origin . . . . .	7
Dorsal profile—End of dorsal to adipose . . . . .	16
Dorsal profile—Adipose to caudal base . . . . .	3
1st row—Along base of dorsal fin . . . . .	5
2nd row—Nape to caudal base . . . . .	39
3rd row—Nape to caudal base . . . . .	39
4th row—Nape to caudal base (lateral line) . . . . .	40
5th row—Opercle to caudal base . . . . .	40
6th row—Opercle to caudal base . . . . .	37
7th row—Along base of anal fin . . . . .	12
Ventral profile—Isthmus to pelvic origin . . . . .	9
Ventral profile—Pelvic to anal origin . . . . .	10
Ventral profile—Anal origin to caudal base . . . . .	2
Total Number of Scales on Body:	
Paired—(212 x 2) . . . . .	424
Unpaired—(47 x 2) . . . . .	94
<hr/>	
Total . . . . .	518

Description of individual scale: The scale illustrated (fig. 28A) is the 21st scale in the second row below the lateral line (the sixth row below the dorsal profile) from the left side of the body immediately above the origin of the anal fin. It is oval, fairly symmetrical, with 5 unequal scallops in the anterior margin. The posterior margin is very thin and fragile. The center is simple, in about the middle of the scale, with the circuli starting at once. There are 35 of them dorsally and ventrally, almost as many anteriorly, but only about a dozen posteriorly. The dorsal and ventral halves of these apical circuli meet at sharp angles in the ventral half of the apical region. Three radii anteriorly connect the deepest scallops with the central region, and three others extend from near the center to the posterior border. There is no trace of annuli. Length of scale 4 mm; breadth of scale 3.2 mm.

The paired fins are broken off short, as are those of the caudal, but the rays are stout and strong, as if they were well ossified, and all double. This applies to a lesser degree in the dorsal and anal, which also appear to be broken. The dorsal, of course, origin-



ates in the anterior half of the fish. The small adipose is placed above the posterior rays of the anal fin.

*Reproductive System:* The specimen seems unquestionably to be a male. The gonads, which are not in breeding condition, are slender and extend the length of the trunk against the dorsal wall of the coelomic cavity.

**SUMMARY OF DEVELOPMENT:** The characteristics of the several growth stages, based upon an examination of all of the specimens in the collection, are as follows:

*Transition between Post-larval and Adolescent Stages:* 8 specimens, from 18 to 22 mm. Body slender (6.7 to 8 in length, not 5.3 to 6.3 as in adolescent and adult); head large (2.7 to 3.25 in length, not 3.3 to 4.5, as in adolescent and adult); eye shorter than or barely equal to post-orbital region; vomerine teeth 1 to 2 pairs; palatine teeth lacking; top of head transparent; upper margin of gill slit opposite middle of eye; scales well developed but with only one-fourth as many circuli as in adult; urostyle tip prominent externally; adipose fin long, contained 1 to 2 times in anal base; traces of predorsal and preanal finfolds; extreme tip of gut projecting; no ossification.

*Adolescent:* 11 specimens, from 24 to 51 mm. Body approaching adult form (depth 5.3 to 6.3 in length); head approaching adult size (length 3.3 to 4.5 in length of fish); eye as in adult, longer than post-orbital region; vomer and palatine teeth together, 5 or 6 pairs, in continuous series; top of head translucent; upper margin of gill slit opposite middle of eye; scales with two-thirds or more as many circuli as in adult specimen; urostyle tip barely visible externally; adipose fin moderate, contained 3 to 6 times in anal base; no traces of predorsal or preanal finfold; no protruding gut; skeleton partially ossified; gonads undeveloped.

*Adult:* 1 specimen, 91 mm. Depth 5.7 in length; head 3.9 in length; vomer and palatine teeth together, 9 pairs, in a continuous series; top of head opaque; upper margin of gill slit opposite lower margin of eye; urostyle tip invisible; adipose fin short, contained about 10 times in anal base; (skeleton presumably entirely ossified); gonads well developed.

## ECOLOGY

VERTICAL AND SEASONAL DISTRIBUTION: Fig. 29 shows the vertical, monthly and yearly distribution of the specimens of

Fathoms	April			May			June			July			Aug.			Sept.			Total		
	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931
400																		1			1
																	1				1
500	1			1					1	2							1		3	2	1
		1			1				1		2						1				6
600	1											1					1		1	1	1
		1									1						1				3
700					1					1			1						2	1	
					1						1			1							3
800	1															1	1		2	1	
		1															2				3
900				3															3		
					3																3
1000										1									1		
											1										1
Total	3			3	2				1	4		1	1			1	3	1	12	5	3
		3			5				1		5			1			5				20

Fig. 29. *Bathylagus benedicti* Goode and Bean. The vertical, monthly and yearly distribution of the specimens taken by the Bermuda Oceanographic Expeditions.

*Bathylagus benedicti* taken off Bermuda. The vertical range lay between 400 and 1000 fathoms, with a mean depth of 660 fathoms. The species, which was found during every month of the trawling season (April to September), was most abundant during the alter-

nate months of May, July and September. (See Figs. 30 and 31). Never before has the species been taken as high as 400 fathoms in a horizontal trawl. (See general distribution chart, Fig. 26).

The table below correlates the data of the graphs just mentioned with length and growth stage (discussed under DEVELOPMENT), and gives in addition average depths and lengths:

RELATION OF MONTH, NUMBER OF SPECIMENS, DEPTH, LENGTH AND GROWTH STAGE

Month	Number	Depth in Fath.:		Length in mm:		Growth Stages
		Extremes	Average	Extremes	Averages	
April	3	500-800;	633	18 to 22;	19.3	Transition
May	5	500-900;	780	18 to 25;	21	Transition, Adolescent
June	1	500	500	27	27	Adolescent
July	5	500-1000;	660	31 to 51;	38.2	Adolescent
August	1	700	700	37	37	Adolescent
Sept.	5	400-800;	620	18 to 91;	40.6	Transition, Adolescent, Adult
Total	20	400-1000;	660	18 to 91;	30.7	Transition, Adolescent, Adult

Although there is no evident relation between depth and season, the correlation of season and length is most pronounced: All of the youngest specimens (Post-larval transition stage) except one were taken in the spring, while the larger adolescents and the single adult were confined entirely to the summer and fall (Fig. 32).

**SOCIABILITY:** *Bathylagus benedicti* shows little evidence of schooling, having been taken singly except in two nets. In each of these two specimens were found, consisting of a transition stage and an adolescent, and of two adolescents, respectively.

**ABUNDANCE:** Both in comparison with *Bathylagus glacialis* and with other deep sea fish *Bathylagus benedicti* is rare. It is represented in 1.8 percent of all of the nets drawn between 400 and 1000 fathoms, the limits of its vertical distribution.

**FOOD:** The stomach contents of the seven specimens examined consisted entirely of small crustaceans, distributed as follows:

Length of Specimen	Contents of Stomach	Depth
18 mm	None	400 Fath.
20 mm	None	600 Fath.
31 mm	None	500 Fath.

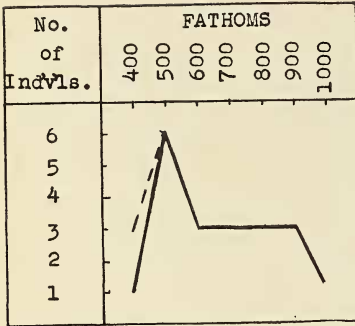


Fig. 30. *Bathylagus benedicti* Goode and Bean. The vertical distribution of the specimens taken by the Bermuda Oceanographic Expeditions. The broken line is based on the number of specimens which would theoretically have been taken at 400 fathoms if as many nets had been drawn at that depth as at the others.<sup>1</sup>

<sup>1</sup> See Introduction, p. 8.

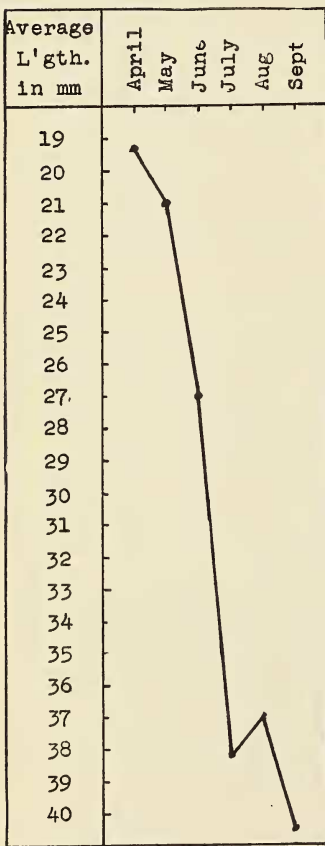


Fig. 32. (Left). *Bathylagus benedicti* Goode and Bean. The relation of seasonal distribution to average length, based upon the total number of specimens taken by the Bermuda Oceanographic Expeditions.

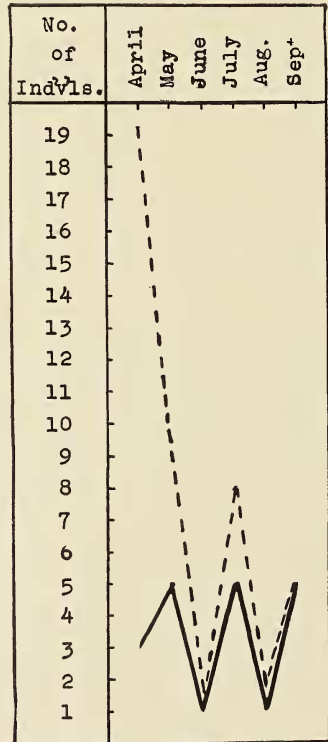


Fig. 31. (Above). *Bathylagus benedicti* Goode and Bean. The seasonal distribution of the specimens taken by the Bermuda Oceanographic Expeditions. The solid line is based upon the actual number of specimens taken, the broken line upon the number which would theoretically have been caught if as many nets had been drawn every month as during September.<sup>1</sup>

<sup>1</sup> See Introduction, p. 7.



<i>Length of Specimen</i>	<i>Contents of Stomach</i>	<i>Depth</i>
35 mm	1 Copepod (length 4.3 mm)	500 Fath.
37 mm	None	700 Fath.
40 mm	7 Copepods (up to 6 mm) 2 young Schizopods 1 young Squilla 1 young Malacostracan (?)	1000 Fath.
91 mm	3 or more minute Copepods 1 Isopod	800 Fath.

Unrecognizable material was present in the intestines of all of the specimens.

#### STUDY MATERIAL

The following list gives the catalogue number, depth in fathoms, date, length and growth stage of each specimen of *Bathylagus benedicti* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described on p. 5. "Transition" indicates specimens intermediate between post-larvae and adolescents.

No. 9,590;	Net 33;	600 F.;	April 24, 1929;	22 mm;	Transition.
No. 9,653;	Net 41;	800 F.;	April 25, 1929;	18 mm;	Transition.
No. 9,721;	Net 45;	500 F.;	April 29, 1929;	18 mm;	Transition.
No. 10,114;	Net 116;	900 F.;	May 18, 1929;	24 mm;	Adolescent.
No. 10,105;	Net 117;	900 F.;	May 18, 1929;	18, 25 mm;	Transition and Adolescent.
No. 11,414;	Net 277;	1000 F.;	July 9, 1929;	40 mm;	Adolescent.
No. 11,512;	Net 285;	500 F.;	July 11, 1929;	31, 35 mm;	Adolescent.
No. 11,796;	Net 322;	700 F.;	July 24, 1929;	34 mm;	Adolescent.
No. 12,418;	Net 380;	700 F.;	Aug. 16, 1929;	37 mm;	Adolescent.
No. 13,071;	Net 419;	800 F.;	Sept. 4, 1929;	37 mm;	Adolescent.
No. 15,416;	Net 625;	500 F.;	May 23, 1930;	18 mm;	Transition.
No. 15,518a;	Net 647;	700 F.;	May 29, 1930;	20 mm;	Transition.
No. 19,116a;	Net 923;	600 F.;	Sept. 20, 1930;	20 mm;	Transition.
No. 19,364;	Net 945;	500 F.;	Sept. 25, 1930;	37 mm;	Adolescent.
No. 19,529;	Net 962;	800 F.;	Sept. 29, 1930;	91 mm;	Adult.
No. 20,810;	Net 1015;	500 F.;	June 15, 1931;	27 mm;	Adolescent.
No. 21,470;	Net 1095;	600 F.;	July 24, 1931;	51 mm;	Adolescent.
No. 23,627;	Net 1324;	400 F.;	Sept. 18, 1931;	18 mm;	Transition.

Nos. 11,414 (KOH No. 860) and 15,416 (KOH No. 1064) have been cleared and stained in order to study the skeleton.

The following paintings and drawings are filed: Colored plate B752; outline drawings B876, B877, and B878.

## SYNONYMY AND REFERENCES

*Bathylagus benedicti*:

Goode and Bean 1895, p. 55, fig. 64 (3 specimens; 112.5 to 144 mm; 1022 to 1769 fath.; off the coasts of New Jersey and Connecticut. Type specimens).

Jordan and Evermann 1896, p. 529. (Résumé of type description).

Norman 1930, p. 277. (4 specimens; 115 to 135 mm; 1025 to 2000 m[- 0]m.; about 1100 to 1400 miles off the coast of Argentina).

Roule and Angel 1933, p. 31. (1 specimen; 108 mm; 0 to 2000 m.; between New Scotland and Bermuda).

*?Bathylagus elongatus*:

Roule 1916, p. 8. (1 specimen; 158 mm; 1500 to 3500 m.; off Cape Finisterre, Spain).

Roule 1919, p. 22, pl. I, fig. 2. (Elaboration of the type description).

***Bathylagus glacialis* Regan 1933**SPECIMENS TAKEN BY THE BERMUDA  
OCEANOGRAPHIC EXPEDITIONS

99 specimens; May to September, 1929 to 1931; 500 to 1000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12' N. Lat., 64° 36' W. Long.; Standard lengths from 23 to 94 mm.

## SPECIMENS PREVIOUSLY RECORDED

12 to 14 specimens; 100 to 1400 fathoms; North and South Atlantic and Antarctic Oceans; Standard lengths from 24 to 135 mm (Fig. 33).

## ADULT SPECIFIC CHARACTERS

(Fig. 34D)

*Bathylagus glacialis* is the only member of the family in which luminous tissue has been found. It is more slender than any of the other species in the genus except *B. gracilis*, *B. microcephalus* and *B. euryops*. From the first it is distinguished by its greater depth (6 to 6.3 in length, not 7 to 7.3), from the second by the longer head (4.1 to 4.6 in length, not 5.2 to 5.3) and from the last by the longer

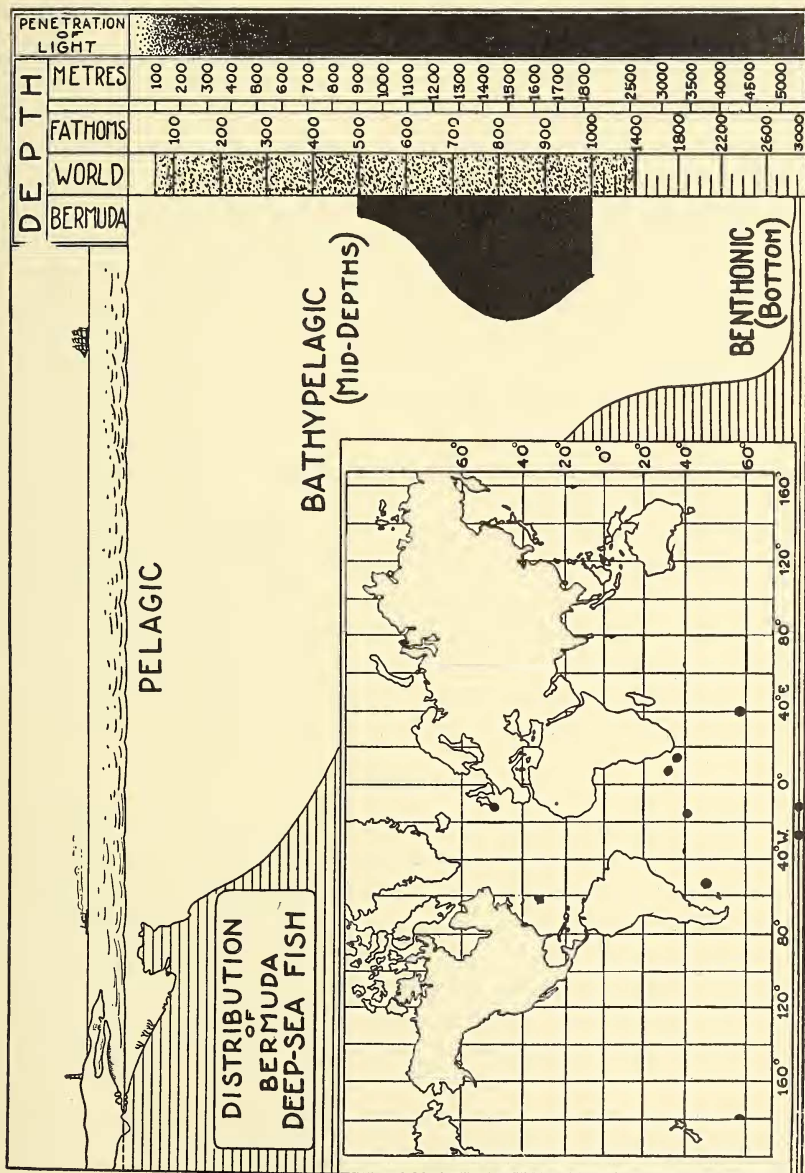


Fig. 33. *Bathylagus glacialis* Regan. The approximate geographical and vertical distribution of all recorded specimens. The relative number of specimens taken at different depths by the Bermuda Oceanographic Expeditions is shown diagrammatically at the right, for comparison with the previously known vertical range of this species.

anal base (not more than 6 in length, instead of 6.2 to 6.7). *Color*: Ground color cinnamon buff, with black chromatophores scattered on head and body beneath the outer epidermis. Lips, iris, opercles, coelom (showing through abdominal skin) and margins of scale pouches, black. The iris and opercles are frosted with silver in the fresh specimen, and the cheeks, isthmus, finbases and outer skin of the entire abdomen are white with a decided silvery sheen. In short, the general coloration closely resembles that of a typically pelagic fish, instead of a species entirely bathypelagic. Luminous material is present on the scales of the posterior part of the body, on the webs of the anal fin, and, sometimes, on those of the caudal. *Proportions*: Depth in length 6 to 6.3; head in length 4.1 to 4.6; eye in head 2.1 to 2.4; interocular in head 2.7 to 3; interorbital in head about 6; snout in head 5.3 to 5.5; origin of anal equidistant from base of caudal and insertion of pelvic or a little nearer the latter, 2.75 to 3.2 times as distant from tip of snout as from base of caudal; length of anal base about 6 in length of fish. *Finray Counts*: Pectoral 10; pelvic 8 to 9½, inserted below middle or posterior part of dorsal; dorsal 10; anal 18 to 21. *Teeth*: All uniserial; minute or absent on premaxillary and maxillary; larger on mandible, articulating with a series of about 12 similar pairs which form a continuous semicircle on vomer and palatines. *Scales*: About 36 to 40 in a longitudinal row. *Gill-rakers*: 13 or 14 in the lower half of the 1st branchial arch.

#### DEVELOPMENT

The Bermuda specimens of *Bathylagus glacialis* form a well graduated series consisting of post-larvae, adolescents, and several adults which are approaching full breeding condition. As will be seen below, there is some shrinkage during metamorphosis, the adolescent stage showing almost no increase in length. The three stages, though having distinct characteristics, are all perfectly linked through transition forms. The relation of these growth stages to standard length and numerical abundance is shown in the table on p. 117.

**EGG**: Well developed, round, white, opaque eggs were found in the ovaries of three specimens. In the largest (94 mm) they measured only .06 mm in diameter and reached an estimated number of 5200 in both ovaries. Small or undeveloped eggs were absent.

**LARVA**: No examples of this stage were taken.



THE RELATION OF GROWTH STAGE TO LENGTH AND NUMERICAL  
ABUNDANCE IN *BATHYLAGUS GLACIALIS*

Length in mm	Larvae	Transitional Larvae	Post-larvae	Transitional Post-larvae	Adolescents	Transitional Adolescents	Adults	Total
23-24			1	2				3
25-26			2	10	12	1		25
27-28			4	6	23	1		34
29-30			1	3	13			17
31-32					1	3		4
33-34						2		2
35-36								
37-38								
39-40						3		3
41-42								
43-44						1		1
45-46						2		2
47-48								
49-50						1		1
51-52								
53-54							1	1
55-56							1	1
57-58								
59-60							1	1
61-62							1	1
63-64								
65-66								
67-68								
69-70								
71-72								
73-74							1	1
75-76							1	1
↓								
94							1	1
			8	21	49	14	7	99

POST-LARVA: (Figs. 34A and 34B). Counting, as usual, the transition forms between post-larvae and adolescents as post-larvae, the Bermuda collection numbers 29 specimens of this growth stage measuring from 23 to 30 mm. It is briefly characterized by the pres-

ence of small, stalked eyes, partially developed paired fins and a greatly elongated adipose—the remnant of a dorsal finfold. A typical example is described below.

*Trawling Data:* All of the observations except those on the

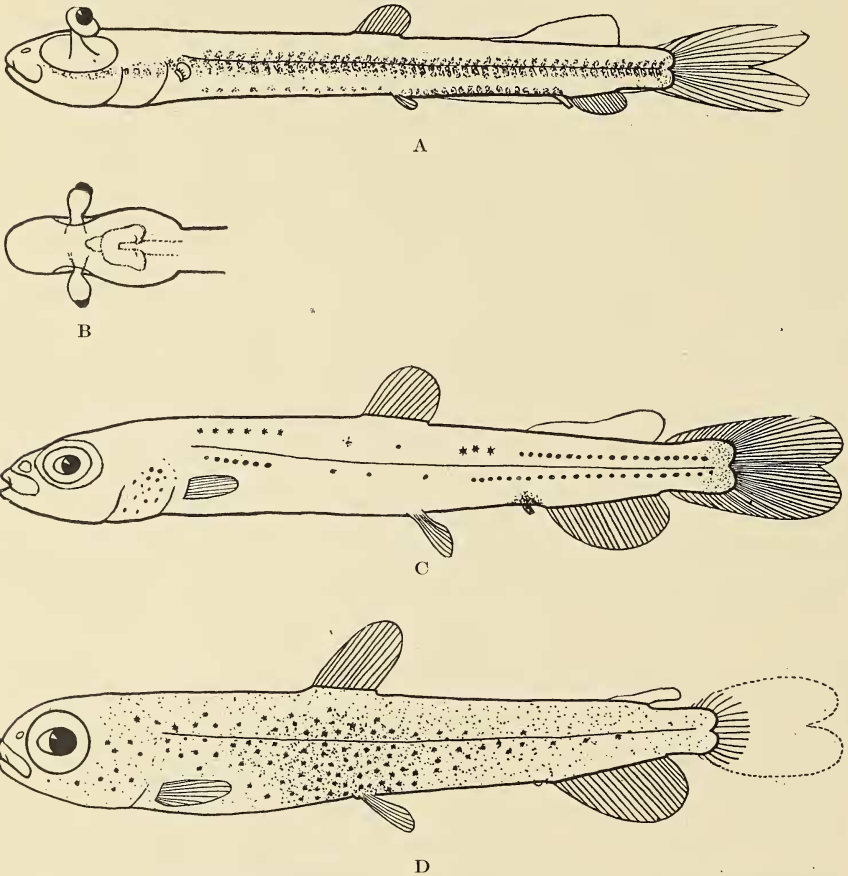


Fig. 34. *Bathylagus glacialis* Regan. A, post-larva, 23.5 mm.; B, same, dorsal view of head; C, adolescent, 30 mm.; D, adult, 94 mm.

skeletal system were made from the following specimen: Department of Tropical Research No. 22,546; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 1193; Aug. 17, 1931; 7 miles south-east of Nonsuch Island, Bermuda; 500 fathoms; Standard length 23.5 mm.

*Measurements and Counts:* Total length 28.2 mm; standard length 23.5 mm; depth 2.1 (in length 11.2); head 5.7 (in length 4.1); eye 1 (in head 5.7); distance from center of pupil to dorsal rim of orbit 1.3; interorbital 1.1 (in head 5.2); snout to anal origin 19.9, the first finray 5.3 times nearer caudal base than tip of snout; anal base 1.6 (in length 14.7); dorsal rays 10; anal rays ca. 15.

*External Characters:* Pigment is practically lacking on the head, much of which is perfectly transparent, except for a smudge of black beneath the eye and another on the opercle. On the white body it is confined to two characteristic series—one above and one below the lateral line—of about 53 black blotches each, one pair to each myomere, the ventral one the darker. To each side of the ventral midline is a row of very black pigment spots extending from the pectoral base to the anal origin.

The dorsal and ventral profiles of the elongate, moderately compressed body are almost parallel from shoulder to caudal base, tapering but slightly in the region of the peduncle only. The bases of the fins are not elevated. The tip of the gut projects very slightly beyond the abdominal wall.

The head, viewed laterally, resembles a slight, almost symmetrical swelling on the end of the body; the snout is flattened and nearly horizontal, while the angle of the jaw, close beneath the orbital socket, scarcely projects at all. The small eyes are elevated on short, translucent stalks, similar to those found in a very young *Stylophthalmus*. The eyes themselves lack the outer, translucent capsule of the older fish, but the sockets which hold the stalks are relatively as much larger than the present diameter of the eye as is that of the adult fish. The nostril is small, far separated from its mate on the other side of the snout, closer to the orbit than to the tip of the snout. The maxillary reaches beyond the vertical from the anterior margin of the orbit.

The premaxillary, maxillary and palatine are toothless. In the mandible are 11 pairs of minute, close-set teeth in the anterior portion, followed by 9 pairs of larger ones, recurved, with small, even spaces between. The vomer holds three pairs of well developed fangs, curved, the outer two pairs the longest, all articulating with the anterior teeth of the mandible.

The gill membranes are perfectly united as in the older fish, and the gill openings characteristically small.

There are no scales whatever.

The pectoral consists of a fleshy basal pad with a fringe of short raylets, the true rays being as yet unformed. The pelvic reaches less than one-eighth of the distance between its insertion, under the middle of the dorsal, and the origin of the anal fin, and its rays are almost entirely undifferentiated. All of the rays of the dorsal are distinct, but the anal is shorter by three or four rays than in adult fishes. The caudal rays are well formed, with the tip of the urostyle protruding between the last rays of the dorsal caudal raylets and the first true, terminal rays. The dorsal adipose finfold is exceedingly long, nearly twice the length of the anal fin and extending from the vertical from the end of the anal almost half of the distance to the end of the dorsal. In depth it is relatively greater than the small adipose of the adult fish. The remains of a shallower finfold extend between the pelvic and anal origins.

There is no trace of luminous tissue.

*Osteology:* In an advanced post-larva (length 28 mm), the vomerine teeth, the jaws, angle of the quadrate, parasphenoid, and the margins of the opercles are quite strongly ossified, while the mandibular teeth, the urostyle and the proximal portions of the caudal rays show a moderate degree of ossification. None of the other bones show the least trace of it.

*Digestive System:* The alimentary canal is a simple, white tube extending from throat to anus close to the ventral profile. It is perfectly straight except for a short, z-shaped fold, the rudiments of the stomach, about 2 mm behind the plane of the pectoral fin.

**ADOLESCENT:** (Fig. 34C). The typically adolescent *Bathylagus glacialis* is characterized by having the eye unstalked, but still only one-half to three-quarters as large as in the adult, while the other proportions, development of scales and skeletal system are similarly immature. The most advanced specimens differ from the adult only in the immature condition of the gonads and the lack of ossification in a very few bones. Altogether, sixty-three examples of this stage were taken, measuring from 25 mm to 50 mm. Examples are described below.

*Trawling Data:* All characters except those of the skeletal system were described from the following specimen: Department of Tropical Research No. 16,948; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 761; July 2, 1930; 12 miles



south of Nonsuch Island, Bermuda; 900 fathoms; Standard length 30 mm.

The observations on the skeleton were made upon Nos. 15,149 (Cleared and Stained Collection No. 861), Standard length 54 mm; 15,518 (Cleared and Stained Collection No. 1063), standard length 31 mm; 16,507, (Cleared and Stained Collection No. 1151), standard length 31 mm.

*Measurements and Counts:* Total length 34.4 mm; standard length 30 mm; depth 4 (in length 7.5); head 7.8 (in length 3.9); eye 2 (in head 3.9); snout 1.7 (in head 4.6); maxillary 1.3 (in head 6); snout to anal origin 22, the first finray 2.8 times nearer the base of caudal than tip of snout; anal base 4.4 (in length 6.8); pectoral rays 10; pectoral length 1.9; pelvic rays  $9\frac{1}{2}$ ; pelvic length 2; dorsal rays 10; anal rays 19; caudal rays XII + 10 + 10 + XI; gill rakers 14.

*External Characters:* General color pale brown. Lips brownish black. Between lips and eye is a pale, translucent area nearly filled by the whitish narial tissue. Up the middle of the snout runs a narrow line of fine chromatophores, broadening in the interorbital region and ceasing abruptly above the middle of the eye. Behind this another translucent, whitish area reveals part of the brain. The isthmus is also translucent. The gill covers are heavily pigmented with fine, black pigment, much more deeply than the remainder of the fish, which is covered by large, interlacing, dendritic chromatophores which give a general effect of light brown. Above the lateral line there is a conspicuous row of larger spots and below it another, similar series. The proximal portions of the rays of the dorsal and pelvic fins are lightly pigmented; all of the other fins colorless, except for a zone of luminous tissue, white and frothy in appearance, which occupies the webs of the anal and lower caudal rays half-way to their tips.

The moderately elongate and compressed body tapers regularly from the shoulders to the base of the caudal, which is about half the maximum depth. The bases of the fins are scarcely elevated.

The crown of the head is almost level with the nape. The curve to the tip of the convex snout and equal lips is gradual, similar to that found between symphysis and preopercles.

The eyes show no trace of stalks externally, being firmly inserted in their orbits and fully sheathed by the transparent outer skin of the eye-ball. The diameter of the latter, just equal to that

of the orbit, is still considerably greater than that of the iris. The nostrils are enormous, almost filling the space between the orbit and the tip of the snout. The maxillary does not quite reach the vertical from the anterior margin of the orbit.

In the exceedingly thin premaxillary are very minute serrations, but no true teeth, while the maxillary lacks even the serrations. The mandible holds about 12 pairs of fine teeth. On the vomer are 2 pairs of stump-like teeth, neither as long nor as sharp as the corresponding ones in the post-larva. Palatine toothless.

Scales are present all over the body, but the majority are not imbricated. Those near the dorsal and ventral profiles, especially, are sometimes separated from the neighboring scales by their full diameter. The specimen is in such good condition and the scaleless places so smooth that it seems unlikely that many have been lost. Altogether, about half as many are present as in the adult. All are perfectly transparent ovals, like thin tissue in consistency, the edges of those on the abdomen loose and whitish, due to the partial development of luminous material. There are no radii, while circuli are indicated by about half-a-dozen exceedingly faint striations. The canal system is a miniature of that found in larger specimens except that the posterior border of each scale is excavated into a deep scallop which extends almost to the central pore. A typical lateral line scale taken at the vertical from the anal origin is .54 mm long by .38 mm broad. A normal scale from the same vertical two rows below the lateral line measures 1.08 mm by .7 mm.

The rays of the paired fins are all well developed. The pelvics reach more than one-fourth of the distance between their insertion and the anal origin, and arise at the vertical from the 7th or 8th dorsal ray. The dorsal originates mid-way between snout and caudal base. The anal and caudal are fully developed. The adipose is as long as the anal fin, with traces of finfold remaining even further forward, almost to the end of the dorsal. Similar traces of the ventral finfold are found in front of the anal.

Half-way to the tips of the anal rays is a zone of white and frothy luminous tissue, occupying the webs. Traces of this continue across the most ventral raylets of the caudal fin, dying out just beyond the base of the true caudal rays. The scales of the lower sides are also bordered with a luminous substance.

*Osteology:* In a typical adolescent of 31 mm the head and opercles are fairly well ossified; the anal fin, the caudal and the urostyle faintly. A specimen of the same length, but with external characters showing it to be in the transition stage between adolescent and adult, has all of the above areas much more strongly ossified, the paired fins moderately so, and the anterior part of the vertebral column faintly. A larger immature specimen of 54 mm has the entire skeleton ossified with the exception of the tips of the finrays, the girdles of the pectoral and pelvic fins and the 14 anterior, rayless baseosts (described on p. 135).

*Digestive System:* The alimentary canal differs from that of the adult (Fig. 42) in three ways: the stomach is proportionately shorter, its first, most dorsal section alone is pigmented and this is comparatively pale, and the caeca are short rudiments. Coelom, dark brown.

*Reproductive System:* The gonads occupy the same relative position as in the adult, against the dorsal wall of the coelom, but are almost invisible, being flat, exceedingly narrow and perfectly transparent.

**ADULT:** (Fig. 34D). Seven fully adult specimens were taken off Bermuda measuring between 54 mm and 94 mm. The stage is characterized by completely developed bodily proportions, ossification and gonads. The largest of the Bermuda specimens, a female, is described below.

*Trawling Data:* Department of Tropical Research No. 11,508; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 290; July 11, 1929; 9 miles south-east of Nonsuch Island, Bermuda; 1000 fathoms; Standard length 94 mm.

*Measurements and Counts:* Standard length 94 mm; depth 16 (in length 6); head 21 (in length 4.6); eye 8.6 (in head 2.4); snout 3.9 (in head 5.4); interocular 7 (in head 3); interorbital 3.6 (in head 5.8); maxillary 5 (in head 4.2); snout to anal 72; the first finray 3.2 times nearer base of caudal than tip of snout; anal base 16 (in length 6); adipose base 1.2 (in anal 13.3); pectoral rays 10; pectoral length 10.7; pelvic rays 9, origin under 7th dorsal ray; length longest pelvic ray 8.6; dorsal rays 10; anal rays 19; caudal rays XI + 10 + 10 + XII; about 40 scales in a longitudinal series; 16 gill-rakers on lower half of first gill arch.

*External Characters:* Ground color cinnamon buff, with a silver sheen ventrally. The under layers of epidermis, beneath the

blackish-edged scale pouches, are thickly speckled with dark brown, slightly dendritic chromatophores. The lips, orbits and coelom wall (visible externally through the abdominal skin) are black. The iris and opercles are also black, but densely frosted with silver. Luminous bands on fins, silvery white.

The moderately elongate body is considerably compressed. Deepest at the shoulders, it tapers gradually to the caudal base, which is less than half of the greatest depth. The fin bases are all slightly elevated.

The general contour of the top of the head is low and rounded. The apex is on a level with the nape and shoulders, the interorbital region somewhat depressed and the short snout convexly curved to the protruding upper lip. Beneath this the lower jaw slants sharply downward and back to its angle at the vertical from the anterior margin of the eye. From here to the pectoral origin the oblique descent of the nearly straight ventral profile is more gradual. The diameter of the eye is less than the length of the postorbital region, its upper margin elevated above the cephalic profile. Socket of eye ball elliptical. The nostrils are placed close to the orbit, separated from each other by the breadth of the snout. The gape slopes sharply downward and back, the maxillary extending to the vertical from the anterior margin of the eye.

Teeth are present in the maxillary, mandible, vomer and palatine. The premaxillary is quite toothless, but has microscopic serrations. In the maxillary a few true teeth, very minute, are scattered. The mandible holds about 25 pairs of tiny teeth, close-set, nearly straight, and of an almost constant diameter. These articulate with the teeth of the vomer and palatine of which there are altogether 12 pairs.

There are numerous pores on the head, arranged in single series along the jaws and isthmus and in a double circle around the eye. They open into a network of canals, presumably part of the lateral line system, which is partially traceable through the thick, translucent, outer epidermis of the head.

Most of the scales are missing, but judging from the pouches, the scales in the anterior part of the body and on the opercula were three or more times the size of those at the caudal base. There were at least 40 scales in the lateral line and six rows, exclusive of the profile rows and those along the bases of the dorsal and anal fins.



Scaled areas: The fish is entirely scaled behind the vertical from the posterior border of the lens of the eye.

Number and arrangement: Due to the loss of many of the scale pouches, it is impossible accurately to count the scales of each row, but the total number is about as follows, excluding those of the head:

Paired scales (ca. 250 x 2).....	500
Unpaired scales (dorsal and ventral profiles).....	40
Total.....	540

Each row extends straight from the nape or opercle to the caudal base.

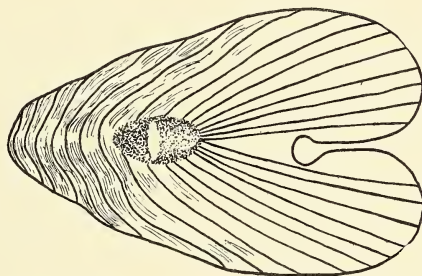


Fig. 35. *Bathylagus glacialis* Regan. Lateral line scale from above anal origin. From an adult specimen, 94 mm. in length. ( $\times 20$ ).

All of the scales on the 94 mm specimen were missing, but a few, well imbricated, remained along the lateral line of a 60 mm fish (No. 17,534). The one illustrated (Fig. 35) is about the 23rd in the lateral line, from the vertical from the anal origin. It is broadest anteriorly, and measures 2.7 mm in length by 1.7 mm maximum breadth. There are 7 or 8 circuli, running around the scale anteriorly, but in the apical portion they extend straight backwards, parallel to the dorsal and ventral borders.

The pectoral fins are inserted very close to the ventral profile, the rays bifid from the base, and the longest of them extending over about a quarter of the distance between their origin and that of the pelvics. The rays of the latter are also double, and of about an equal length, the longest reaching a third of the way between the pelvic and anal origins. The dorsal fin commences nearer the snout than the caudal base. The distance from the anal origin to the base

of the caudal is about equal to that between the pelvic and anal origins. Adipose inserted opposite the posterior anal rays.

The skin of the abdomen, the proximal portions of the anal and lower caudal rays are covered with a thin coating of frothy, silvery white, luminous material.

*Osteology:* A specimen (No. 13,585) measuring 74 mm in length is strongly ossified; its detailed description follows.

*Skull:* (Figs. 36 and 38). In general the bones of the head are well ossified but exceedingly delicate. Most of them are of similar thickness throughout, with few ridges or areas of more deeply concentrated bony tissue, the principal exceptions being the angle of the quadrate, the hyomandibular, the opercles and the branchiostegal rays.

From above, the broad and flattened cranium is divided into three general areas. The most posterior, or cranium proper, includes the entire postorbital region and is dominated by the large, central, quadrilateral supraoccipital. Somewhat broader than long, it extends back into a short spine above the deeply imbedded atlas, and in front as far as the plane of the end of the orbit. It is bounded posteriorly by the triangular epiotics and anteriorly by the parietals, of similar shape to the epiotics and touching them lateral to and below the supraoccipital. The oval pterotics are visible from above, below the parietals and posterior to the sphenotics.

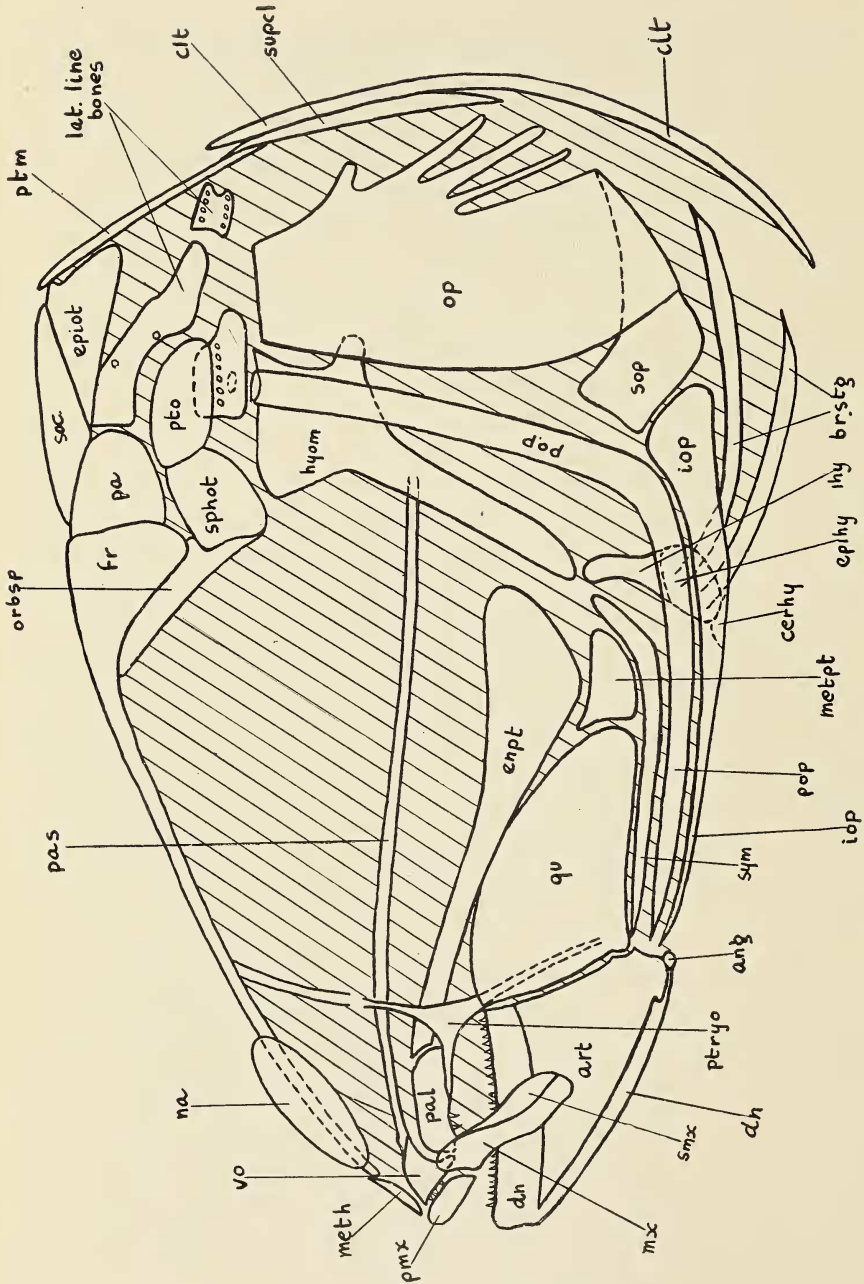
The median section of the cranium covers the whole of the interorbital region and is twice as large as either the postorbital or antorbital section. The broadly expanded, fused frontals occupy two-thirds of the space, the supraorbitals and postfrontals the remainder. The posterior border of the frontal is almost straight, lying between the posterior extension of the postfrontal, contiguous to the sphenotics and parietals, but not in contact with the supraoccipital. Laterally, the frontals have broad margins bent upwards to encase the ocular tissues, which project above the level of the rest of the head and are surmounted by the broad, leaf-like postfrontals and the supraorbitals, over twice as long as the first bones. The prefrontals extend downwards along the anterior margin of the orbit, directly beneath the anterior part of the supraorbitals.

The leaf-like nasal bones occupy most of the length of the preorbital region of the dorsal aspect of the skull. They are superficial and close together, separated only by the narrow tongue which is

the anterior extension of the frontals. This tongue ends in a forked tip close beneath the apex of the triangular metethmoid. The base of the latter is separated from the slenderly curved premaxillaries by a definite gap. Maxillaries, palatines, entopterygoid and pterygoids can be seen deeper down in the broad snout, far lateral to the nasals.

*Palato-pterygoid arcade:* The deeply imbedded hyomandibular commences dorsally beneath the sphenotic and pterotic, sending off a short, posterior arm to articulate with the opercle, interior to the upper, anterior margin of the latter. Then, well behind the orbit, a long, rather slender arm extends in an obliquely ventral direction and ends in front of the angle of the preopercle, above the interhyal and tip of the symplectic. The latter bone is an elongate shaft, straight except for the upturned, posterior end, which bounds the small metemapterygoid posteriorly and ventrally and the large, fan-shaped quadrate along its entire lower edge. Both metemapterygoid and quadrate are inclined sharply inwards, and are overlaid by the jugal, as subsequently to be described. Above and interior to them the elongate, posteriorly expanded entopterygoid forms the roof of the gullet. Anteriorly it joins the oblong palatine, which in turn connects with the vomer in front and the pterygoid laterally. The pterygoid is a triangular bone with three slender spines: The anterior joins the palatine; the most dorsal runs upward, exterior to the entopterygoid, along the anterior margin of the orbit, almost meeting the prefrontal; and the third and largest extends postero-ventrally behind and in contact with the anterior portion of the quadrate, terminating just above the articulation of the jaw. The slender parasphenoid runs from the vomer back through the center of the head, between the eyes, with a slight upward curve in its anterior portion.

*Jaw apparatus:* The premaxillaries, although entirely edentulous, are well ossified, not fused in the midline nor touching any of the surrounding bones. The maxillaries, likewise without teeth but deeply stained, extend obliquely downward, exterior to the middle of the solidly constructed dentary. The articular, with boundaries very faintly marked, occupies almost the entire space between the V formed by the dorsal, toothed side of the dentary and its antero-ventral boundary. The angular is minute and rounded, well below the junction of the articular with the quadrate. The mandibular teeth are ossified only at their bases; the larger ones of vomer and palatine throughout their lengths.





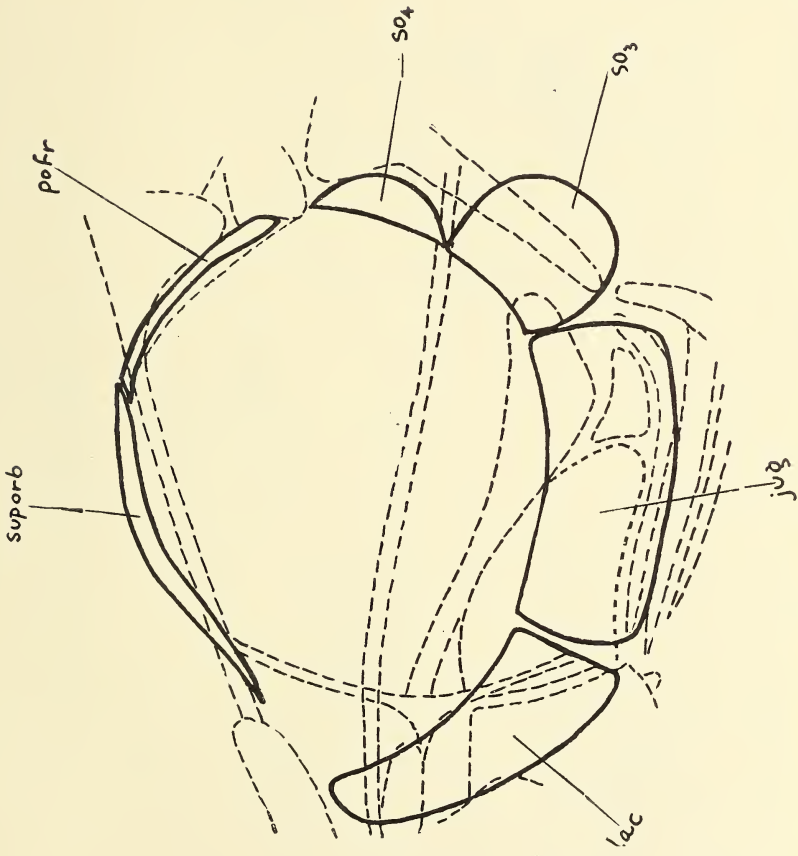


Fig. 36. (Above). *Bathylagus glacialis* Regan. Skull, hyoid arch and opercular bones, lateral view. The circumorbital bones have been omitted.  
Fig. 37. (Below). *Bathylagus glacialis* Regan. Circumorbital bones. The broken lines indicate the boundaries of the underlying bones depicted in fig. 36.

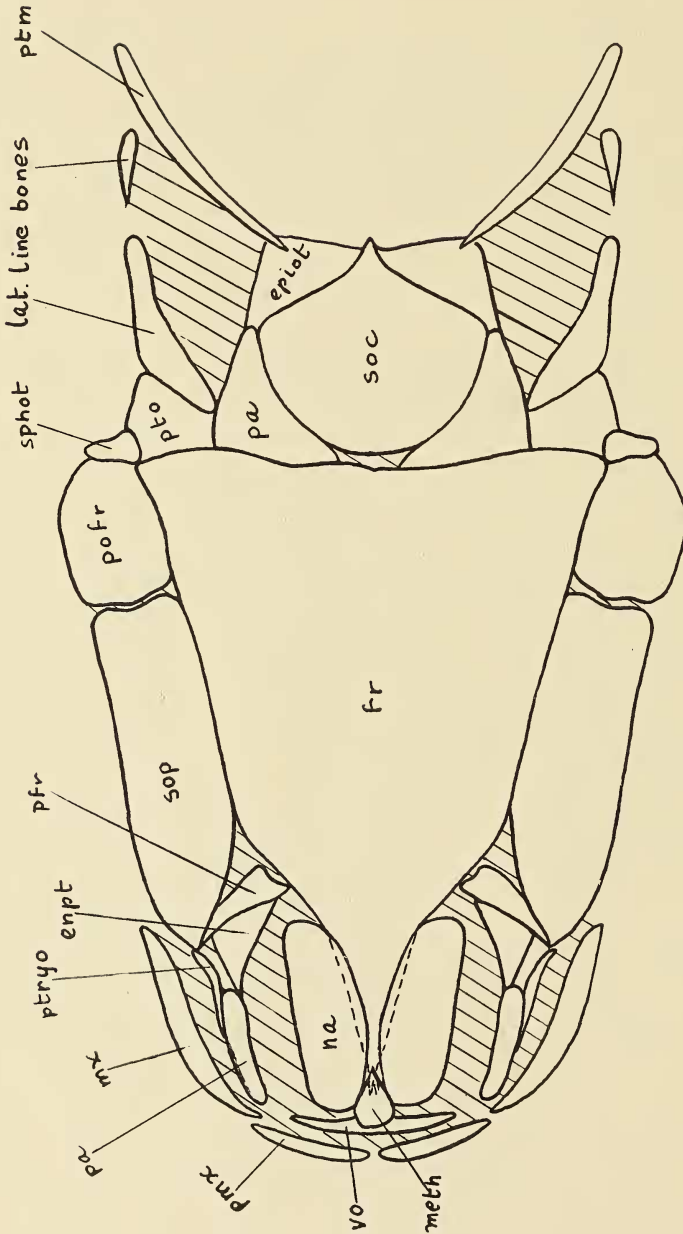


Fig. 38. *Bathylagus glacialis* Regan. Skull, dorsal view.



*Opercular bones:* Preopercle, interopercle and subopercle are all strongly ossified and comparatively sturdy; the opercle on the other hand is but lightly stained and very fragile, especially posteriorly, except for the margins of three to six posterior, comb-like ridges which extend obliquely downward. These are more numerous on the right side of the fish than on the left. The posterior part of the subopercle lies just interior to the opercle, its anterior portion filling the space between the opercle and the expanded head of the interopercle. The latter extends forward as a thin, exceedingly elongate bone beneath and partially interior to the corresponding part of the preopercle, both ending barely in back of the articular. Posteriorly the preopercle curves almost straight upward between opercle and hyomandibular, passing exterior to the short, posterior branch of the latter and terminating level with the top of the opercle. At this point it is seen that at least the upright arm of the preopercle is quite hollow, with the end almost in contact with an unidentified, poriferous bone.

*Cephalic bones of the lateral line:* The poriferous bone just mentioned has its dorsal portion lying interior to the pterotic and all of it is well imbedded in the tissues; there is little doubt but that it belongs to the lateral line system. There are two other bones, similar in character but lying almost on the surface and quite unconnected with the cranium. The first, a narrow oblong, lies between epiotic and pterotic. The second, small and oval, extends between the first bone and the origin of the lateral line proper, above the opercle. Both are well ossified, the longer one having several irregular pores, the smaller showing four pairs of perforations along the dorsal and ventral edges.

*Circumorbital bones:* (Fig. 37). Due to the great size of the eyes, the supraorbital and postfrontal, as already described, roof rather than border the eye-ball, while the circumorbital bones have been pushed down exterior to the bones of the palato-pterygoid arcade. All are greatly expanded, delicate, superficial and only moderately well ossified. The lacrymal is an extensive oblong, its anterior, upper end overlying the posterior part of the upper jaw, its vertical and posterior the articular as far as the jaw angle. The jugal covers as much distance externally as do both quadrate and metemapterygoid inside, and reaches from the orbit to the vertical arm of the preopercle. Dividing the space between the jugal and



the small sphenotic there are but two circumorbitals; a broad one extending across the hyomandibular to the vertical preopercular arm and a small, semicircular plate, dorsal to this and not reaching the hyomandibular. A moderate-sized orbito-sphenoid lies interior to sphenotic and frontal.

*Hyoid arch:* (Fig. 39). The tip of the short and rather slender interhyal thrusts up between the symplectic and the hyomandibular, while its lower end is in contact with the rounded epihyal. From the latter bone arise the two flat, slightly curving branchiostegals; each of these has a low, median keel. The spindle-shaped ceratohyal is four times the length of the epihyal and almost touches the basihyal. The basihyals are slightly longer than broad, with pronounced ridges opposed to each other and nearly in contact across the ventral midline. Passing beneath these bones toward the basibranchials is the stem of the large glossohyal, a deeply imbedded, cone-shaped, feebly ossified bone with its base in about the same plane as the posterior part of the maxillary.

*Pectoral girdle:* The slender post-temporal is attached dorsally to a short spine on the lower, posterior corner of the epiotic. Post-temporal, supracleithrum and cleithrum all articulate at about the level of the dorsal rim of the opercle, the top of the supracleithrum lying wedged between the ventral tip of the post-temporal and the dorsal end of the cleithrum. The supracleithrum, always anterior to the cleithrum, reinforces it as far down as the lower third of the opercle, where it terminates. The cleithrum continues ventrally in a broad curve. The bone is twisted and folded throughout its length, with several lateral expansions. The shape of the large and thin post-clavicula cannot be exactly determined, as it is only feebly ossified, and this in patches only. Three pterygials are moderately well ossified.

*Vertebral column and fins:* (Fig. 40). The vertebral column and all its appendages are strongly ossified. Including the axis and urostyle there are 53 vertebrae. These are of similar size (1.4 mm long by .7 mm minimum diameter) as far back as the posterior part of the anal. Posterior to this they are slightly smaller.

The axis has a short, neural protuberance only. Following this are two vertebrae without ribs but similar in every other way to the succeeding 28, ribbed elements. In these the neurapophyses are

not united as far back as the 26th vertebra, well behind the end of the dorsal fin; they arise from the anterior part of the centrum as a

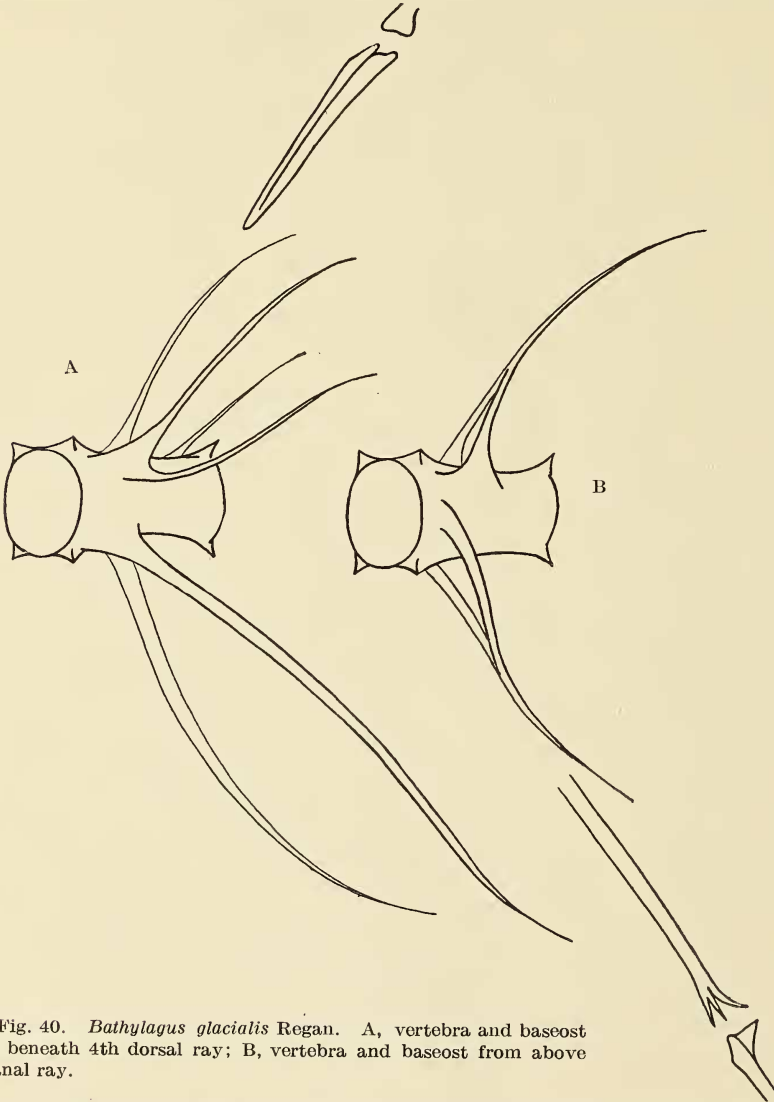


Fig. 40. *Bathylagus glacialis* Regan. A, vertebra and baseost from beneath 4th dorsal ray; B, vertebra and baseost from above 7th anal ray.

pair of slender spines, about twice as long as the centrum itself. From the 26th on, however, the distal two-thirds of each pair are fused, forming typical neural arches. From their bases arise ex-

ceedingly delicate epipleural spines, directed outwards and back, four-fifths the length of the entire neural element. There is no trace of a haemal arch in front of the 27th vertebra; at this point, however, a pair of tiny, short spines is visible at the front of the parapophyses. At the 29th, they are much larger and unite in the median line, forming a complete haemal arch with a short haemal spine. Several vertebrae behind this the spine lengthens to equal the neural spine; the succeeding ones are similar, until the first modifications of the caudal base appear (see below).

Ribs are found on the third through the thirty-second vertebrae inclusive. They arise from broad parapophyses far down on the sides of the anterior halves of the centra. Normally they are about twice as long as the neuropophyses, but the last six are progressively reduced in size and their origins shifted gradually outward along the haemal arch.

Anterior and posterior zygapophyses are well developed.

There are 14 dorsal baseosts which lack finrays. The first is very small and close to the second, both anterior to the first neural spine, arising from the first vertebra back of the atlas. Close in front of the base of the first dorsal ray three baseosts radiate, the first two short and pointing forward. These three exactly make up the number to fill the three empty inter-neural-spine intervals to the fourth, which is the normal baseost of the first dorsal ray. This undoubtedly is a degenerate condition, reflecting an ancestor which must have had a strong, continuous fin from the neck backward. These extra baseosts are the last bones in this species to show traces of ossification, although they are as strongly ossified as the succeeding baseosts in the present specimen. There is a single baseost for each dorsal ray, extending downward from the finray base in front of and between the tips of each pair of neural spines. In the anal fin the first and last rays, very short though strongly ossified, lack support; otherwise one baseost is opposed to each ray. All of the baseosts have thickened cores, four-pointed dorsal tips and delicate, lateral flanges.

*Caudal fin and end of vertebral column:* (Fig. 41). The first vertebra to show any caudal specialization is the 46th or seventh before the urostyle. This and the succeeding one have the neural and haemal spines lengthened, and articulating with the anterior caudal raylets. The 48th in addition shows a slight,

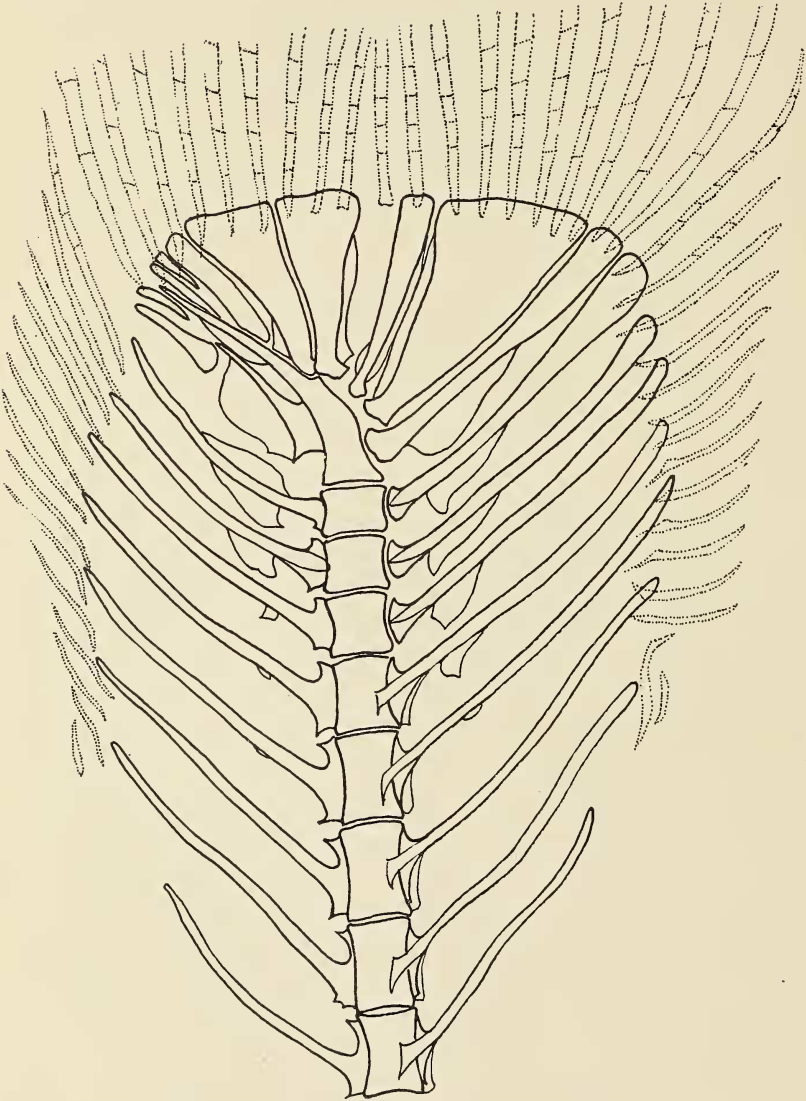


Fig. 41. *Bathylagus glacialis* Regan. Caudal vertebrae and finrays.  
(Preparation and drawing by Gloria Hollister)

median, anterior keel of bone at the base of the spines. This incurves to a wide and elongate bony wing on the succeeding four



vertebrae, the neural spine of the last showing the keel developed on both central and posterior sides of the spine.

The urostyle extends far up and back, almost to the epural, neural-spine contour. It bears on the anterior side near the bone an elongate, enlarged neural arch and spine having a wide, thin keel. There are two epurals, the anterior twice as long and wide inferiorly as its fellow. In the ventral aspect of the urostyle we count eight hypurals, the first very similar to the preceding hypaxial element. The second hypural (1.9 x .9 mm) is the largest bone in the caudal complex, twice as long as it is wide posteriorly. The third hypural is narrow and closely connected with the second. The fourth is wide and parallel with the vertebral column and almost as great in extent as the fifth. The sixth is much smaller, but elongate and flattened, while the seventh and eighth hypurals are small splinters of bones like the epurals.

The sequence of external elements is XIII + 10 + 12 + 13.

The anterior five dorsal raylets are sloped more and more sharply forward, but only the two anterior ventral raylets are thus specialized, lying horizontally, almost at right angles to the remainder.

*Digestive System:* (Fig. 42). The following measurements were taken on a specimen of 75 mm (No. 17,534): Oesophagus and

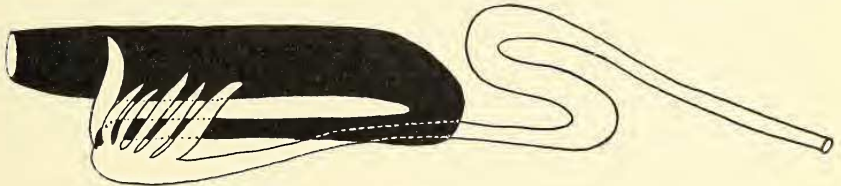


Fig. 42. *Bathylagus glaiialis* Regan. Alimentary canal.

stomach to its most posterior extent, 18.6 mm long, 2.9 mm in diameter; pyloric canal (from posterior end of stomach to base of caeca) 13.9 mm long, 1.1 mm in diameter; intestine 68.9 mm, equal in average diameter to the pyloric canal except immediately posterior to the middle of its length, where there is a short portion somewhat swollen. There are six caeca, the longest measuring 4.3 mm in length, the shortest 2.9; diameter of the longest, .7 mm. The liver is bi-lobed, each half measuring 4.3 mm long by 2.9 mm in maximum breadth. Coelom, oesophagus, stomach and pyloric canal, jet black; intestine and caeca, white.

*Reproductive System:* In the female of 94 mm the ovaries lie against the dorsal wall of the coelom and are about 50 mm long by .65 mm broad. They are very flat, with the minute eggs arranged in single, double and triple layers.

A female of 60 mm with unripe eggs was taken in the same net as a 75 mm male. The testicles of the latter exactly correspond in relative size and position to the ovaries of the female, and seem about spent.

**SUMMARY OF DEVELOPMENT:** The following résumés of the characteristics of each growth stage are based on a study of all of the specimens in the Bermuda collection.

*Summary of the Changes Taking Place During Growth*

*Post-larva:* 23 to 29 mm. Two characteristic rows of lateral pigment spots, one above and one below lateral line; body slender (depth in length 10 to 11.5, not 6 to 6.3 as in adult); eyes stalked, small; vomerine teeth 1 or 2 pairs; no palatine teeth; no scales; pectoral rays undifferentiated; pelvic reaching about one-eighth of distance between insertion and anal; anal with from 1 to 4 rays fewer than adult; urostyle tip prominent; adipose finfold much longer than anal base; traces of pre-anal finfold; extreme tip of gut projecting; ossification absent or present only on jaws, quadrate angle and opercular margins.

*Transition:* 23 to 30 mm. Eye sunk into orbit, but smaller than latter and not attached to either its rim or sides; one or more other post-larval characters remaining combined with those of the adolescent, given below.

*Adolescent:* 25 to 31 mm. Post-larval pigment spots persisting; body approaching adult depth (depth in length 6.8 to 7.4, not 6 to 6.3 as in adult); eyes firmly attached to orbit, but with the iris small, the whole encased in a thick, transparent membrane, the entire diameter of which is contained only about 4 times in the head (instead of 2.2 to 2.4, as in the adult), and is considerably less than the length of the post-orbital region; vomer and palatine with 2 to 4 pairs of teeth altogether, smaller than in post-larva; scales developing; finrays all well developed; pelvic extending over one fourth to one-half of the distance between its insertion and the anal origin, having 9 or 10 rays; urostyle tip almost invisible; adipose finfold about equal to anal base,

except for occasional traces, very shallow, further forward; tip of gut may project; ossification partial (head and proximal parts of finrays only).

*Transition:* 26 to 50 mm. Like adult, except that there are 6 or more (but not 12) pairs of vomerine and palatine teeth alto gether, the two lateral rows of pigment spots persist, ossification is incomplete, gonads immature, and luminous tissue generally undeveloped.

Fathoms	May			June			July			Aug.			Sept.			Total		
	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931
500		2						1			1					3	1	
		2					1			1						4		
600	2	1					2		2			2				4	1	3
	3						3				2					8		
700		1			3			3	1			3	4	4	2	4	1	6
		1			3			4			3		10			21		
800		2		3	6		1	1				3	1	5	4	5	14	7
		2		9			2			3			10			26		
900				1	3		3	5		2			3	5	1	9	13	1
				4			8			2			9			23		
1000				1			2			5		1	7	1		15	1	1
				1			2			6			8		17			
Total	2	6		5	12		8	10	2	7		10	15	15	7	37	43	19
	8			17			20			17			37			99		

Fig. 43. *Bathylagus glacialis* Regan. The vertical, monthly and yearly distribution of the specimens taken by the Bermuda Oceanographic Expeditions.

*Adult*: 54 to 94 mm. Depth in length 6 to 6.3; eyes contained 2.2 to 2.4 times in head, equal to or larger than post-orbital region; vomerine and palatine teeth about 12 pairs altogether; scales and luminous material fully developed; pelvic extending over more than one-half the distance between its insertion and anal origin; sometimes a vestigial tenth ray found in pelvic fin; urostyle entirely internal; adipose finfold lacking, the adipose fin being but a small fraction of the anal base in length; tip of gut not projecting; ossification complete; gonads mature.

## ORDER OF DEVELOPMENT OF PRINCIPAL CHARACTERS

## KEY:

..... Development rudimentary.

----- Half developed

———— Fully developed (i. e. in regard to appearance and proportions, but not in actual size).

	LARVA	POST-LARVA	ADOLESCENT
<i>Number of Specimens</i>	29	63	7
<i>Locality</i>	Bermuda	Bermuda	Bermuda
<i>Season</i>	June to Sept.	May to Sept.	May to Sept.
<i>Vertical Distribution</i>	500 to 1000 F.	500 to 1000 F.	700 to 1000 F.
<i>Length</i>	23 to 30 mm	25 to 50 mm	54 to 94 mm
<i>Growth Characters</i>			
Finfolds	.....	.....	.....
Post-larval pigment	-----	-----	-----
Dorsal fin	-----	-----	-----
Caudal fin	-----	-----	-----
Anal fin	-----	-----	-----
Pectoral fin	-----	-----	-----
Pelvic fin	-----	-----	-----
Body form	-----	-----	-----
Eyes	.....	.....	.....
Mandibular teeth	-----	-----	-----
Vomer and palatine teeth	.....	.....	.....
Alimentary canal	.....	.....	.....
Ossification of skull	-----	-----	-----
Scales	.....	.....	.....
Ossification of fins	.....	.....	.....
Gonads	.....	.....	.....
Luminous tissue	.....	.....	.....
Ossification of vertebrae	-----	-----	-----
Ossification of girdles	-----	-----	-----



## ECOLOGY

VERTICAL AND SEASONAL DISTRIBUTION: Fig. 43 shows the vertical, monthly and yearly distribution of the Bermuda specimens of *Bathylagus glacialis*. The vertical range lay between 500 and 1000 fathoms, with a mean depth of 808 fathoms. Even on the basis of an equal number of nets each month, the species was rare in the spring, most abundant in September (Figs. 44 and 45). The world distribution map (Fig. 33) shows the Bermuda depths side by side with those of the specimens previously recorded, for purposes of comparison.

The table below correlates the data of the graphs just mentioned with length and growth stage (discussed under DEVELOPMENT) and gives in addition average depths and lengths:

RELATION OF MONTH, NUMBER OF SPECIMENS, DEPTH, LENGTH  
AND GROWTH STAGE

Month	Number	Depth in Fath.: Extremes Average		Length in mm: Extremes Average		Growth Stages
May	8	500-800	638	26 to 55	31.5	Adolescent Adult
June	17	700-1000	818	25 to 46	33.1	Post-larva Adolescent
July	20	500-1000	795	25 to 94	33.1	Post-larva Adolescent Adult
Aug.	17	500-1000	824	23 to 30	27.2	Post-larva Adolescent
Sept.	37	700-1000	841	24 to 75	31.9	Post-larva Adolescent Adult
Total	99	500-1000	808	23 to 94	31.5	Post-larva Adolescent Adult

Much of the data of this table is presented in graph form in Fig. 46. A study of both table and graph results in the following conclusions:

1. In Bermuda *Bathylagus glacialis* is taken on an average of more than 100 fathoms higher in the spring than in late summer and fall.

2. Specimens in all stages of growth, beginning with the post-larva and ending with adults in almost full breeding condition, were

taken from May to September, showing no evident correlation with depth or season.

**SOCIABILITY:** In two nets three specimens were found together; in eight, two immature fish; and in one net, a pair of young adults, male and female, not in breeding condition.

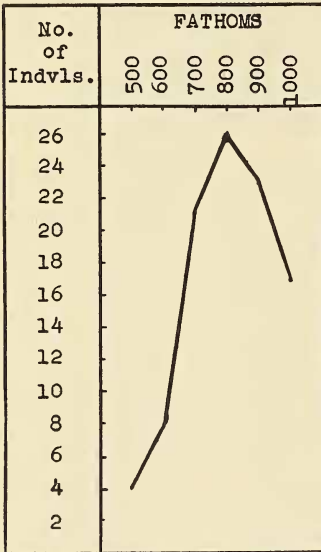


Fig. 44. (Left). *Bathylagus glacialis* Regan. The vertical distribution of the specimens taken by the Bermuda Oceanographic Expeditions.

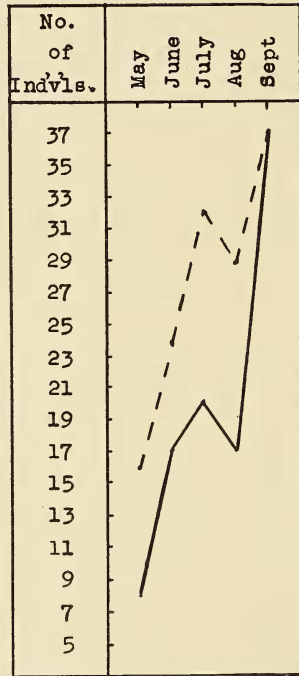


Fig. 45. (Right). *Bathylagus glacialis* Regan. The seasonal distribution of the specimens taken by the Bermuda Oceanographic Expeditions. The solid line is based upon the actual number of specimens taken, the broken line upon the number which would theoretically have been caught if as many nets had been drawn every month as during September.<sup>1</sup>

**ABUNDANCE:** *Bathylagus glacialis* is uncommon among the deep-sea fishes taken off Bermuda. It occurred in 9.5 per cent of all the nets drawn between 500 and 1000 fathoms, the limits of its vertical distribution.

**FOOD:** The stomachs of ten specimens, measuring from 30 to 96 mm were opened. All were entirely empty, with one exception, a 64 mm fish whose stomach contained a single copepod. The specimens examined were taken between 600 and 1000 fathoms.

<sup>1</sup> See Introduction, p. 7.

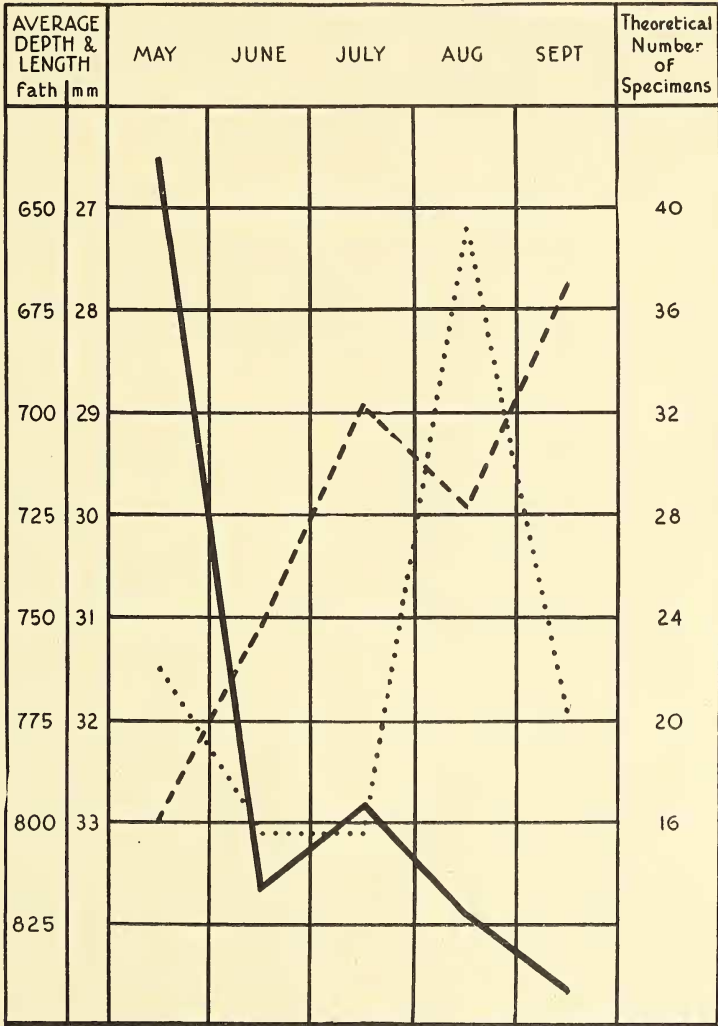


Fig. 46. *Bathylagus glacialis* Regan. The relation of month of capture to average length (dotted line), average depth (solid line) and theoretical numerical abundance<sup>1</sup> (broken line), all based on the total number of specimens taken by the Bermuda Oceanographic Expeditions.

STUDY MATERIAL

The following list gives the catalogue number, depth in fathoms, date of capture, length and growth stage of each specimen of *Bathyl-*

<sup>1</sup> See fig. 45 and Introduction, p. 7.

*lagus glacialis* taken by the Bermuda Oceanographic Expedition. All were caught in the cylinder of water off the Bermuda coast described on p. 5. The abbreviations "P.-lar. Trans." and "Adol. Trans." stand for post-larval transition stage and adolescent transition stage, respectively.

No. 9,748;	Net 64;	600 F.;	May 4, 1929;	30 mm;	Adolescent.
No. 10,261;	Net 141;	600 F.;	May 31, 1929;	26 mm;	Adol. Trans.
No. 10,392;	Net 162;	900 F.;	June 6, 1929;	28 mm;	Adol. Trans.
No. 10,717;	Net 198;	1000 F.;	June 20, 1929;	25 mm;	Adolescent.
No. 10,891;	Net 214;	800 F.;	June 24, 1929;	46 mm;	Adol. Trans.
No. 10,960;	Net 220;	800 F.;	June 25, 1929;	30 mm;	Adolescent.
No. 10,963;	Net 220;	800 F.;	June 25, 1929;	27 mm;	Post-larva.
No. 11,239;	Net 252;	900 F.;	July 4, 1929;	25 mm;	P.-lar. Trans.
No. 11,237;	Net 253;	1000 F.;	July 4, 1929;	30 mm;	Adolescent.
No. 11,508;	Net 290;	1000 F.;	July 11, 1929;	94 mm;	Adult.
No. 11,635;	Net 306;	600 F.;	July 16, 1929;	25, 26 mm;	Post-larva & P.-lar. Trans.
No. 11,860;	Net 328;	800 F.;	July 27, 1929;	26 mm;	Adolescent.
No. 11,877;	Net 330;	900 F.;	July 27, 1929;	25, 26 mm;	P.-lar. Trans.
No. 24,139;	Net 351;	1000 F.;	Aug. 8, 1929;	26 mm;	Adolescent.
No. 12,179;	Net 365;	1000 F.;	Aug. 10, 1929;	29 mm;	Adolescent.
No. 24,150;	Net 371;	1000 F.;	Aug. 14, 1929;	26 mm;	P.-lar. Trans.
No. 12,433;	Net 382;	900 F.;	Aug. 16, 1929;	26, 26 mm;	P.-lar. Trans. & Adolescent.
No. 12,498;	Net 389;	1000 F.;	Aug. 17, 1929;	30 mm;	Adolescent.
No. 12,595;	Net 395;	1000 F.;	Aug. 23, 1929;	23 mm;	P.-lar. Trans.
No. 12,982;	Net 413;	900 F.;	Sept. 3, 1929;	30 mm;	Adolescent.
No. 13,189a;	Net 435;	1000 F.;	Sept. 6, 1929;	26 mm;	P.-lar. Trans.
No. 13,228;	Net 440;	900 F.;	Sept. 7, 1929;	28 mm;	Adolescent.
No. 13,239;	Net 442;	1000 F.;	Sept. 7, 1929;	27, 27, 27 mm;	P.-lar. Trans.
No. 13,349;	Net 449;	1000 F.;	Sept. 9, 1929;	28, 28 mm;	Adolescent.
No. 13,423;	Net 460;	700 F.;	Sept. 11, 1929;	30 mm;	P.-lar. Trans.
No. 13,468;	Net 466;	900 F.;	Sept. 12, 1929;	28 mm;	Adolescent.
No. 13,477;	Net 468;	1000 F.;	Sept. 12, 1929;	29 mm;	Adolescent.
No. 13,584;	Net 480;	700 F.;	Sept. 20, 1929;	28 mm;	Adolescent.
No. 13,585;	Net 480;	700 F.;	Sept. 20, 1929;	74 mm;	Adult.
No. 13,637;	Net 487;	800 F.;	Sept. 21, 1929;	28 mm;	P.-lar. Trans.
No. 13,782;	Net 507;	700 F.;	Sept. 25, 1929;	26 mm;	Adolescent.
No. 14,803;	Net 552;	600 F.;	May 9, 1930;	27 mm;	Adolescent.
No. 14,905;	Net 565;	500 F.;	May 12, 1930;	27, 27 mm;	Adolescent.
No. 15,078;	Net 590;	800 F.;	May 17, 1930;	28 mm;	Adolescent.
No. 15,149;	Net 598;	800 F.;	May 19, 1930;	55 mm;	Adult.
No. 15,518;	Net 647;	700 F.;	May 29, 1930;	32 mm;	Adol. Trans.
No. 15,696;	Net 665;	700 F.;	June 4, 1930;	44 mm;	Adol. Trans.



- No. 15,771; Net 682; 800 F.; June 7, 1930; 34, 40 mm; Adol. Trans.  
No. 15,832; Net 686; 800 F.; June 9, 1930; 27 mm; Adolescent.  
No. 16,036; Net 701; 800 F.; June 13, 1930; 30, 31 mm; Adolescent &  
Adol. Trans.  
No. 15,991; Net 711; 800 F.; June 16, 1930; 34 mm; Adol. Trans.  
No. 16,054; Net 713; 700 F.; June 17, 1930; 40, 40 mm; Adol. Trans.  
No. 16,256; Net 721; 900 F.; June 25, 1930; 28 mm; P.-lar. Trans.  
No. 16,261; Net 722; 900 F.; June 25, 1930; 27 mm; Adolescent.  
No. 16,507; Net 748; 900 F.; June 30, 1930; 31 mm; Adolescent.  
No. 16,927; Net 760; 700 F.; July 2, 1930; 54 mm; Adult.  
No. 16,948; Net 761; 900 F.; July 2, 1930; 30 mm; Adolescent.  
No. 16,953; Net 778; 700 F.; July 5, 1930; 31 mm; Adol. Trans.  
No. 16,761; Net 788; 900 F.; July 7, 1930; 29, 29, 30 mm; Adolescent  
(2) & P.-lar. Trans.  
No. 17,042; Net 801; 900 F.; July 15, 1930; 27 mm; Adolescent.  
No. 17,190; Net 804; 500 F.; July 16, 1930; 28 mm; Post-larva.  
No. 17,060; Net 806; 700 F.; July 16, 1930; 45 mm; Adol. Trans.  
No. 17,204; Net 807; 800 F.; July 16, 1930; 29 mm; Adolescent.  
No. 17,534; Net 825; 800 F.; Sept. 1, 1930; 60, 75 mm; Adults.  
No. 17,634; Net 832; 900 F.; Sept. 2, 1930; 28 mm; Adolescent.  
No. 17,791; Net 839; 700 F.; Sept. 3, 1930; 50 mm; Adol. Trans.  
No. 17,958; Net 850; 800 F.; Sept. 5, 1930; 26 mm; P.-lar. Trans.  
No. 18,030; Net 857; 900 F.; Sept. 6, 1930; 61 mm; Adult.  
No. 18,101; Net 862; 800 F.; Sept. 8, 1930; 27 mm; Adolescent.  
No. 18,115; Net 864; 1000 F.; Sept. 8, 1930; 26 mm; Adolescent.  
No. 18,497; Net 883; 700 F.; Sept. 13, 1930; 25 mm; Adolescent.  
No. 18,502; Net 884; 800 F.; Sept. 13, 1930; 26 mm; Adolescent.  
No. 18,513; Net 886; 900 F.; Sept. 13, 1930; 26 mm; Adolescent.  
No. 18,684; Net 896; 700 F.; Sept. 16, 1930; 28 mm; Adolescent.  
No. 18,723; Net 905; 900 F.; Sept. 17, 1930; 25 mm; Adolescent.  
No. 19,139; Net 925; 900 F.; Sept. 20, 1930; 24 mm; P.-lar. Trans.  
No. 19,057; Net 930; 700 F.; Sept. 22, 1930; 27 mm; Adolescent.  
No. 21,554; Net 1104; 700 F.; July 25, 1931; 27 mm; P.-lar. Trans.  
No. 21,611; Net 1109; 600 F.; July 27, 1931; 26 mm; P.-lar. Trans.  
No. 21,807; Net 1123; 700 F.; Aug. 3, 1931; 30 mm; Adolescent.  
No. 21,904; Net 1133; 700 F.; Aug. 5, 1931; 28 mm; Adolescent.  
No. 22,323; Net 1175; 600 F.; Aug. 14, 1931; 28 mm; Post-larva.  
No. 22,330; Net 1177; 800 F.; Aug. 14, 1931; 30 mm; P.-lar. Trans.  
No. 22,546; Net 1193; 500 F.; Aug. 18, 1931; 23 mm; Post-larva.  
No. 22,530; Net 1194; 700 F.; Aug. 18, 1931; 29 mm; Post-larva.  
No. 22,549; Net 1196; 800 F.; Aug. 18, 1931; 27, 28 mm; Adolescents.  
No. 22,619; Net 1200; 600 F.; Aug. 19, 1931; 27 mm; Post-larva.  
No. 22,909; Net 1245; 1000 F.; Aug. 31, 1931; 27 mm; Adolescent.  
No. 22,977; Net 1251; 900 F.; Sept. 1, 1931; 28 mm; Adolescent.  
No. 23,062; Net 1256; 700 F.; Sept. 3, 1931; 25 mm; Post-larva.  
No. 23,119; Net 1263; 800 F.; Sept. 4, 1931; 28 mm; Adolescent.

- No. 23,193; Net 1273; 800 F.; Sept. 7, 1931; 25 mm; P-lar. Trans.  
No. 23,318; Net 1292; 700 F.; Sept. 12, 1931; 26 mm; Adolescent.  
No. 23,367; Net 1298; 800 F.; Sept. 14, 1931; 25 mm; Adolescent.  
No. 23,674; Net 1328; 800 F.; Sept. 19, 1931; 27 mm; Adolescent.

The following specimens were cleared and stained in order to study the skeleton: No. 13,584 (KOH No. 944); No. 15,149 (KOH No. 861); No. 15,413 (KOH No. 635); No. 15,518 (KOH No. 1063); No. 16,507 (KOH No. 1151); No. 22,323 (KOH No. 1152).

Colored plates, outline drawings and photographs are filed under the following numbers: Colored plate B614; outline drawings B879, B880, B881, B882, B883; photograph B5346-L.

#### SYNONYMY AND REFERENCES

##### *Bathylagus glacialis*:

Regan, 1913 (part), p. 231, pl. IX, fig. 2. (4 specimens 80 to 100 mm; [one of the five types mentioned is *B. euryops* according to Norman, 1930, p. 275], 800 to 1400 [-0] fathoms; Antarctic Ocean. *Type Specimens*.)

Norman, 1930, p. 275, (*Discovery*: 6 specimens; 24 to 118 mm; 112 to 1350 (-0) M.; west of Cape Town; south of Tristan d'Acunha; northeast of Falkland I. *Nat'l. Mus. of Ireland*: 1 specimen; 135 mm; 695 to 720 fath.; Co. Kerry, S. W. Ireland).

##### *Bathylagus antarcticus*: (part).

Brauer, 1906, p. 13, fig. 2: (1 to 3 specimens, depending upon how many of the four mentioned are actually *B. antarcticus*; between 42 and 133.5 mm; 1500 to 2000 M.; Antarctic, south of Cape Town, Bouvet Island and Enderby Land).

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